# Economics of Forest Protection and Management Research Work Unit (SRS-4851) Technical Assistant Visit 2003

USDA Forest Service, Southern Research Station
Research Triangle Park, North Carolina
November 21, 2003

## Introduction

This document provides background information for discussing a plan for the forest economics research program at the Southern Research Station, USDA Forest Service. This plan, called a Research Work Unit Description, will define major problem areas and studies for the next five years. We will discuss the specifics of the plan at a Technical Assistance Visit December 2-3, 2003 in Raleigh, North Carolina.

The document is divided into six sections:

1. A brief introduction to the document including a Unit history

2. A draft of the research plan, which will organize discussions at the TAV

3. A description of research capacity, including research staff and collaborative efforts

4. A summary of research productivity over the previous 5-year research cycle

5. An Accomplishment Report describing our research results over these 5 years

6. A listing of publications by the Unit from FY1999 onward, with abstracts

Thank you for your interest in our research program and your willingness to help us plan for future work.

## Unit History

The Economics of Forest Protection and Management Work Unit was chartered in 1993 with the merger of two units that focused on the economics of timber investment and land use and the economic aspects of forest protection. The mission of the unit has expanded over time and now fully encompasses the broad field of natural resource economics as applied to questions of forest management, policy, and assessment. Research spans local, regional, national, and international scales.

Problem Areas defined by the 1998 Research Work Unit Description reflect the breadth of the research: (1) Assessment of Southern Timber Markets, (2) Spatial Assessment of Change in the South's Forests, (3) Measures of Sustainability, (4) Understanding Values of Forest Goods and Services on Different Land Ownerships, and (5) Forest Policy.

Since 1998, SRS-4851 has conducted research in all five of these areas and has pursued other research deemed essential to the agency and funded from outside sources. This includes a substantial effort in the economics of fire management and policy (National Fire Plan and Joint Fire Sciences Program), the economics of various forest pests (including the hemlock woolly adelgid), land use forecasting for the RPA, and linking land use with ecological effects within the Coweeta Long Term Ecological Research program.

Capstone products from the previous five years of work include a book on the economics of forests in a market economy and the Southern Forest Resource Assessment. In addition, the unit has produced more than 170 publications since 1998, reflecting substantial progress in addressing this multiple-front research mission. Quality is indicated by the high share of publications in refereed journals (44 percent).

Research has been accomplished both in-house and jointly with numerous cooperators from other Forest Service units and more than thirty universities. The unit has provided leadership for the Southern Forest Assessment Consortium (SOFAC), a cooperative effort involving nine firms and the USDA Forest Service to improve the analysis and forecasts of timber markets in the South.

## Proposed Research Plan 2004-2008

The Research Work Unit Description (RWUD) for SRS-4851 is scheduled to expire in 2003. The staff of SRS-4851 is now preparing for our next RWUD. Our initial steps have involved (1) a careful assessment of research progress in the five problem areas listed above, (2) an evaluation of questions that remain or that have emerged from that research, (3) new research areas that have arisen over the past five years, and (4) a general assessment of research needs defined by the Southern Forest Resource Assessment and the Southern Research Station's Strategic Framework.

The broad mission of SRS-4851 is natural resource economics applied to questions of forest management, policy, and assessment. Our research focuses on developing new methodologies and applying economics to policy- and management-relevant questions. As a result of our initial preparations, we have drafted four new problem areas for the work unit:

- **Economics of forest disturbances**
- **Forest management, markets, and trade**
- **Values of forest amenities and services**
- **Economics of broad scale human-forest interactions**

Consistent with our work over the past ten years, we anticipate that our research will be focused at a variety of scales, from the watershed to the region to the nation. We anticipate continuing work on international projects as needs arise. While the 1998 RWUD contained a separate Problem Area labeled "Forest Policy," the proposed RWUD is designed to address forest policy questions in each of the new problem areas.

These four problem areas are described in the pages that follow. They provide the starting point for discussions about our future research with constituencies both inside and outside the Forest Service.
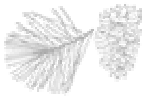
# Proposed Problem Area 1: Economics of forest disturbances

Natural disturbances such as fire, pests, and weather have long been important factors influencing the structure and health of forests.   During the last two decades, however, both natural and human disturbances to forests have increased with the growth of the wildland-urban interface, changing climate patterns, and the increasing mobility of people, insects and plants across the world.   Government expenditures for fire suppression and management have ballooned over the last few years.   Nonnative forest pests, diseases, and invasive plant species threaten the health and the economic value of U.S. forests for timber production, recreation, wildlife habitat, and water quality protection.   Hurricanes, ice storms, and drought have destroyed forests and/or made them more vulnerable to fire, pests, and diseases with resulting negative impacts on local and regional economies.  Research is needed to evaluate the economic impacts of these disturbances at local, regional, and national levels; to evaluate economically optimal solutions to prevent or reduce the damages; and to develop public policies in response to these disturbances.

Problem Statement: <u>Improve information and analytical methods for assessing the efficiency and equity impacts of forest management, policy, programs, regulations, and landowner incentives to address the prophylactic, emergency, and restorative needs associated with broad scale forest disturbances</u>.

## Study Areas:

- Economics of wildfire and fuels management
- Economics of extreme weather events
- Economics of pests, pathogens, and invasive plants
- Public policy and disturbances
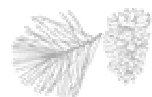
# Proposed Problem Area 2: Forest management, markets, and trade

The U.S. is the world's largest producer and consumer of forest products, and the South produces more timber than any other single nation. The nation's timber and forest product markets are affected by domestic and international trade policies, ownership structures, producer and consumer preferences, technology, and ecological variables. Trade liberalization, economic growth, demographic change, forest sector development, and emergence of foreign forest products markets have resulted in trade flow increases, contributing in unknown ways to ownership shifts, market adjustments, and land use changes. Market models require correct representations of market structures in order to correctly quantify how recent and future changes in these factors translate into changes in trade patterns, land use, and forest-based production across space and over time. Accuracy of these models is limited by knowledge of how land, timber, and forest product markets are related spatially and temporally; incomplete representation of timber investment behavior; an inadequate characterization of the processes underlying technological change; and incomplete understanding of forestland owner and consumer preferences.

Problem Statement: <u>Refine understanding of how forest and trade policies, catastrophic shocks, market structure, forestland ownership, demographic factors, and technology affect timber supply, timber trade, land use, and forest sector benefits.</u>

## Study Areas:

- Landowner behavior, investment, and regional timber supply
- Spatial and temporal dynamics of timber markets
- Economic impacts of shocks to timber markets
- Technological change, timber markets, and forest conditions
- International trade effects on timber markets
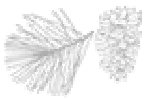
# Proposed Problem Area 3: Values of forest amenities and services

Forests produce value for members of society, and, at the same time, are shaped in structure and composition by the values held by forest owners, interest groups, and the public at large. The heterogeneity of forest land uses reflects the mix of values and incentive structures that guide forest management and protection decisions. Many of the environmental and amenity services supplied by forests, such as clean water and attractive landscapes, are public goods that provide benefits to all members of society whether they are produced on public or private forests. An increase in the demand for forest amenities, in combination with a shrinking supply, has led to increasing scarcity. Because forest amenities are non-priced and may take decades or longer to produce, they are undersupplied. Thus, at the landscape scale, the mix of forest and other land uses that result from individual decisions may not lead to the best mix for society as a whole. In addition to human influences, forest conditions are affected by biotic (insects and diseases) and abiotic (fires, windstorms) disturbances. A better understanding of how changes in forest conditions alter the value of forests and how various segments of society are impacted by such changes will help forest managers and land use planners identify forest values at risk and design policies that enhance the quality of life for all members of society.

Problem statement: <u>Improve methods for measuring non-market values provided by forests; identify forest amenity values, how they are distributed over members of society and across geographical regions; develop strategies to utilize non-market values in decision-making.</u>

## Study Areas:

- Non-market valuation of forest and landscape characteristics
- Demands for forest amenities and services by segments of society
- Impacts of biotic and abiotic disturbances on non-market values
- Effective use of non-market values in planning and decision-making
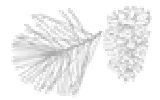
## Proposed Problem Area 4: Economics of broad scale human-forest interactions

Changes in society have led to increased demands for forest goods and services and tightened supplies of forestland to supply these goods and services. Changes in the structure and characteristics of existing forests also affect the ability of forests to meet societal demands for solitude, biodiversity, adventure and wood products. Supplying these benefits will have effects on nearby communities, affecting both the quality of life and the standard of living in regional economies. Research is needed to evaluate and forecast the effects of resource production on forest extent and condition, the effects of changing forest ecosystem conditions and resource use patterns on human communities, and the effects of various policies and institutions on resource conditions, conservation goals, and communities. Research in this problem area will address the sustainability of forests and the associated human communities by (1) estimating models of relationships between social factors, land use, and forest fragmentation, (2) conducting simulations of various scenarios for resource, land uses, and community impacts, and (3) cataloguing and projecting forest conditions, uses and values.

Problem statement: <u>Improve methods for integrated assessments at regional and national scales; identify emerging resource problems; provide policy-relevant insights into communities and conservation issues.</u>

### Study Areas:

- Effects of various resource demands on forest structure and function
- Impacts of forest conditions and uses on local and regional economies
- Policy impacts on communities and forest ecosystems
- Forecasts of land use, forest structure and function, and fragmentation

# Research Capacity

The capacity of the Unit to conduct research can be defined by its physical and human resources, and the organizations and individuals with whom it collaborates.

## Physical Resources

- Facility- The Unit is housed in two 1960's era buildings on the wooded 26 acre Forestry Sciences Laboratory campus in Research Triangle Park. Unit space includes eleven offices, one small conference room, and a larger commons/conference area, with access to additional space shared with other Units at the Lab.

- Computer hardware- Project staff upgraded this past year to new corporate-standard PCs. Additional laptop and desktop computers provide extra computing power for mobile or stationary needs. Other crucial but more dated resources include four laser printers and shared access to the Lab network with its two AIX servers and wide format plotter.

- Computer software- The Unit has augmented corporate-standard applications like Office XP, ArcGIS, and SAS with current versions of NLogit, EViews, Solver, and SigmaPlot, plus the complete US Census dataset from Geolytics. It also has made substantial investments in web authoring software.

# Collaborations

## Cooperative Research

Following are some of the institutions with which the Unit has conducted cooperative research since 1999.

| | |
|---|---|
| *Auburn University* | *Triangle Economics Research* |
| *Clemson University* | *University of Florida* |
| *Colorado State University* | *University of Georgia* |
| *Duke University* | *University of Maine* |
| *Mississippi State University* | *University of Maryland* |
| *North Carolina A&T State University* | *University of Minnesota* |
| *North Carolina Central University* | *University of Tennessee* |
| *North Carolina State University* | *University of Washington* |
| *Northeastern Research Station* | *University of Wisconsin* |
| *Pacific States Marine Fisheries Comm.* | *Virginia Polytechnic Inst. & State Univ.* |
| *Research Triangle Institute* | *Western Carolina University* |
| *Rutgers University* | *World Agroforestry Centre* |
| *State University of New York* | |

## Southern Forest Assessment Consortium (SOFAC)

The Southern Forest Resource Assessment Consortium was organized in 1994 to broadly improve analysis of the South's forest resources--developing timber supply models for use in the South, improving analysis of existing forest inventory data, and coordinating

southern resource assessment research and application efforts. SOFAC's goal is to give forest managers and policy-makers the data and the models they need to make sound decisions in a rapidly changing world. SOFAC supports research and applications which analyze local and regional forest resource conditions, management alternatives, and policy scenarios.

A second phase of SOFAC was started in 1999. Research now focuses on building a "second-generation" timber market-land use-forest inventory modeling system for the South. This research is being conducted by a team of researchers from North Carolina State University, Research Triangle Institute, the US Forest Service, and University of Georgia.

SOFAC has been cooperative endeavor of the USDA Forest Service Research, private firms, and state forestry agencies. These organizations contribute funding and participate as voting members. Twelve contributing members now comprise the organization.

In addition to these ongoing research projects, SOFAC has been involved in providing input to the USDA Forest Service national timber assessment, coordinating public meetings on the timber assessment's approach and data needs. SOFAC's research results have also been provided to other Forest Service analysts.

## USDA National Needs Fellowship Program in Forest Products Marketing and Management

The Unit cooperates with the Economics Graduate Program at North Carolina State University in sponsoring a USDA fellowship program to train scientists in forest products marketing and management. The program offers comprehensive training in economic theory and econometrics as well as specialized training in fields chosen by the fellows and their graduate committees. Fellows participate in research projects conducted within the work unit.

# Human Resources

Research cooperators and organizational affiliations expand the Unit's research capacity, but the productivity of our Unit is fundamentally reliant upon the capabilities of our in-house research team:

- **David N. Wear**, Research Forester and Project Leader
- **Karen L. Abt**, Research Economist
- **Renee Boozer**, Project Secretary
- **David Butry**, Economist and PhD Student
- **Thomas P. Holmes**, Research Forester/Economist
- **D. Evan Mercer**, Research Economist
- **Jeffrey Prestemon**, Research Forester/Economist
- **John M. Pye**, Ecologist

# David N. Wear

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## Education

Ph.D. University of Montana, 1987 (Forest Management and Economics)

M.F. Duke University, 1983 (Resource Systems Science)

B.A. University of Montana, 1981 (Botany) with honors

## Experience

Project Leader, USDA Forest Service, Economics of Forest Protection and Management, Research Triangle Park, NC. 1994-present

Research Forest Economist, USDA Forest Service, Southern Research Station, Research Triangle Park, NC. 1987-1994

Information Manager and Analyst, Lolo National Forest, USDA Forest Service, Missoula, Montana. 1985-1987

Operations Research Analyst, Lolo National Forest, USDA Forest Service, Missoula, MT. 1983-1985

Planning Staff, Lolo National Forest, USDA Forest Service, Missoula, MT. 1979-1981

## Academic Experience

Adjunct Faculty, Duke University, School of the Environment. 1988-present

Adjunct Faculty, North Carolina State University, College of Natural Resources 1991-present

Instructor, University of Montana. 1984 Research and Teaching Assistant, Duke University and University of Montana. 1981-1986

## Recent Publications

### 1998 (1)

Wear, D.N. and Bolstad, P. 1998. Land-use changes in Southern Appalachian landscapes: spatial analysis and forecast evaluation. *Ecosystems* 1:575-594.

### 1999 (4)

Cubbage, F.W.; Siry, J.; Abt, R.; Wear, D. and Moffat, S. 1999. Forest productivity and timber supply modeling in the South. *Conference Proceedings: Improving Forest Productivity for Timber.* Duluth, MN, 1999.

Prestemon, J.P. and Wear, D.N. 1999. Inventory effects on aggregate timber supply. *Proceedings of the 1998 Southern Forest Economics Workshop.* Research Triangle Park, NC, 1999.

Wear, D.N. 1999. Challenges to interdisciplinary discourse. *Ecosystems* 2:299-301.

Wear, D.N.; Foreman, J.M. and Sheffield, R.M. 1999. The effects of population growth on timber management and inventories in Virginia. *Forest Ecology and Management* 118:107-115.

## 2000 (6)

Hardie, I.; Parks, P.; Gottleib, P. and Wear, D. 2000. Responsiveness of rural and urban land uses to land rent determinants in the U.S. South. *Land Economics* 76(4):659-673.

Parks, P.J.; Hardie, I.W.; Tedder, C.A. and Wear, D.N. 2000. Using resource economics to anticipate forest land use change in the U.S. Mid-Atlantic region. *Environmental Monitoring and Assessment* 63:175-185.

Prestemon, J.P.; Pye, J.M.; Abt, K.L.; Wear, D.N. and LeDoux, C. 2000. Market definition for hardwood timber in the Southern Appalachians. *Proceedings of the 1999 Southern Forest Economics Workshop*. Starkville, MS, 2000.

Prestemon, J.P. and Wear, D.N. 2000. Linking harvest choices to timber supply. *Forest Science* 46(3):377-389.

Wear, D.N. 2000. Regional assessment and interregional comparisons of forest investment. *Proceedings of the 1999 Southern Forest Economics Workshop*. Starkville, MS, 2000.

Wear, D.N. 2000. Forest land use changes: fragmentation, urbanization and population. *Proceedings: Perspectives on Sustainable Forestry for the South*. Raleigh, NC, 2000.

## 2001 (3)

Clark, J.S.; Carpenter, S.R.; Barber, M.; Collins, S.; Dobson, A.; Foley, J.A.; Lodge, D.M.; Pascual, M.; Pielke, R., Jr.; Pizer, W.; Pringle, C.; Reid, W.V.; Rose, K.A.; Sala, O.; Schlesinger, W.H.; Wall, D.H. and Wear, D. 2001. Ecological forecasts: an emerging imperative. *Science* 293(5530):657-660.

Murray, B.C.; Abt, R.C.; Wear, D.N.; Parks, P.J. and Hardie, I.W. 2001. Land allocation in the Southeastern U.S. in response to climate change impacts on forestry and agriculture. *World Resource Review* 13(2):239-251.

Johnsen, K.H., D.N. Wear, R. Oren, R.O. Teskey, F. Sanchez, R. Will, J. Butnor, D. Markewitz, D.Richter, T. Rials, H.L. Allen, J. Seiler, D. Ellsworth, C. Maier , G. Katul, and P.M. Dougherty. 2001. Meeting Global Policy Commitments: Carbon sequestration and southern pine forests. **Journal of Forestry** 99(4): 14-21. Refereed

## 2002 (6)

Greis, J.G. and Wear, D.N. 2002. Conducting science in the public eye. *Journal of Forestry* 100(7):46-49.

Wear, D.N. 2002. Chapter 6: land use. In: D.N. Wear and J.G. Greis (Eds.) *Southern forest resource assessment*. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station.

Wear, D.N. and Greis, J.G. 2002. Southern forest resource assessment: summary of findings. *Journal of Forestry* 100(7):6-14.

Wear, D.N. and Greis, J.G. 2002. Southern forest resource assessment. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station.

Wear, D.N. and Greis, J.G. 2002. The southern forest resource assessment: summary report. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station.

Wu, L.; Alavalapati, J.; Carter, D.; Wear, D. and Das, G. 2002. Assessing the impact of trade policy and technology changes in the U.S. forestry sectors. *Proceedings of the 2001 Southern Forest Economics Workshop*. Auburn, AL, 2002.

## 2003 (9)

Conway, M.C.; Amacher, G.S.; Sullivan, J. and Wear, D. in press. Decisions nonindustrial forest landowners make: an empirical examination. *Journal of Forest Economics*.

Hardie, I.W.; Parks, P.J.; Gottleib, P. and Wear, D.N. 2003. Responsiveness of rural and urban land uses to land rent determinants in the South. In: P.J. Parks and I.W. Hardie (Eds.) *The Economics of Land Use*. Hampshire, England: Ashgate Publishing Ltd.

Prestemon, J.P.; Buongiorno, J.; Wear, D.N. and Siry, J.P. 2003. Chapter 11: international trade in forest products. In: E. Sills and K.L. Abt (Eds.) *Forests in a market economy*. Dordrecht, Netherlands: Kluwer Academic Publishers.

Swallow, S.K.; Parks, P.J. and Wear, D.N. 2003. Chapter 19: policy relevant nonconvexities in the production of multiple forest benefits. In: R.A. Sedjo (Ed.) *Economics of forestry*. Hampshire, England: Ashgate Publishing Ltd.

Turner, M.G.; Pearson, S.M.; Bolstad, P. and Wear, D.N. 2003. Effects of land-cover change on spatial pattern of forest communities in the Southern Appalachian Mountains (USA). *Landscape Ecology* 18(5):449-464.

Wear, D.N. 2003. Chapter 4: large-scale regional assessments: lessons learned from the Southern Appalachian Assessment. In: V.H. Dale (Ed.) *Ecological Modeling for Resource Management*. New York, NY: Springer-Verlag.

Wear, D.N. 2003. Chapter 12: public timber supply under multiple-use management. In: E. Sills and K.L. Abt (Eds.) *Forests in a market economy*. Dordrecht, Netherlands: Kluwer Academic Publishers.

Wear, D.N. and Greis, J.G. 2003. Assessing the South's forests. *Forest Landowner* 62(2):27-29.

Wear, D.N. and Pattanayak, S. 2003. Chapter 8: aggregate timber supply: from the forest to the market. In: E. Sills and K.L. Abt (Eds.) *Forests in a market economy*. Dordrecht, Netherlands: Kluwer Academic Publishers.

### in press        (4)

Nagubadi, V.; Zhang, D.; Prestemon, J.P. and Wear, D.N. in press. Softwood lumber products in the United States: substitutes or complements? *Forest Science*.

Wear, D.N. and Greis, J.G. in press. Lessons learned from the Southern Forest Resource Assessment. In: M. Rauscher; K. Johnsen and R. Doudrick (Eds.) *Southern Forest Science: Past, Present and Future*.

Wear, D.N. and Murray, B.C. in press. Federal timber restrictions, interregional spillovers, and the impact on U.S. softwood markets. *Journal of Environmental Economics and Management*.

Wear, D.N. and Prestemon, J.P. in press. Timber market research, private forests, and policy rhetoric. In: M. Rauscher; K. Johnsen and R. Doudrick (Eds.) *Southern Forest Science: Past, Present, Future*.

## Karen Lee Abt

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## Education

Doctor of Philosophy, North Carolina State University, 1997, Forestry and Economics

Master of Science, Colorado State University, 1987, Forest Economics

Bachelor of Arts, California State University, Long Beach, 1978. Geography

## Experience

Research Economist, USDA Forest Service, Southern Research Station, 1988 to present.

Operations Research Analyst, USDA Forest Service, Beaverhead National Forest, Dillon, MT, 1988.

Operations Research Analyst, USDA Forest Service, Land Management Planning, Fort Collins, CO, 1986-1987.

Community Development Planner, City of Loveland, CO, 1985-1986.

City Planner, City of Irvine, CA, 1980-1984.

City Planner, City of Carlsbad, CA, 1979-1980.

## Recent Publications

### 1999   (2)

Abt, K.L.; Greene, J.L. and Abt, R.C. 1999. Chapter 6 - Timber Resources [in Ozark-Ouachita Highlands Assessment Report 4 - Social and Economic Conditions]. Asheville, NC: USDA Forest Service, Southern Research Station.

Busby, R.L.; Abt, K.L. and Redmond, C. 1999. Chapter 4 - Economic Profile [in Ozark-Ouachita Highlands Assessment Report 4 - Social and Economic Conditions]. Asheville, NC: USDA Forest Service, Southern Research Station.

### 2000   (4)

Prestemon, J.P.; Pye, J.M.; Abt, K.L.; Wear, D.N. and LeDoux, C. 2000. Market definition for hardwood timber in the Southern Appalachians. *Proceedings of the 1999 Southern Forest Economics Workshop*. Starkville, MS, 2000.

Raunikar, R.; Buongiorno, J.; Prestemon, J. and Abt, K.L. 2000. Biological and economic productivity of mixed-aged loblolly pine stands in the South. *Proceedings of the 1999 Southern Forest Economics Workshop*. Starkville, MS, 2000.

Raunikar, R.; Buongiorno, J.; Prestemon, J.P. and Abt, K.L. 2000. Financial performance of mixed-age naturally regenerated loblolly-hardwood stands in the South Central United States. *Forest Policy and Economics* 1(3/4):331-346.

Scarpa, R.; Buongiorno, J.; Hseu, J.-S. and Abt, K.L. 2000. Assessing the non-timber value of forests: a revealed-preference, hedonic model. *Journal of Forest Economics* 6(2):83-107.

### 2001   (1)

Prestemon, J.P.; Mercer, D.E.; Pye, J.M.; Butry, D.T.; Holmes, T.P. and Abt, K.L. 2001. Economically optimal wildfire intervention regimes. *Proceedings, American Agricultural Economics Association Annual Meeting*. Chicago, IL, 2001.

### 2002   (1)

Abt, K.L.; Winter, S.A. and Huggett, R.J. 2002. Chapter 10:  local economic impacts of forests. In: D.N. Wear and J.G. Greis (Eds.) *Southern forest resource assessment*. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station.

### 2003   (6)

Abt, K.L. and Prestemon, J.P. 2003. Chapter 4:  optimal stand management:  traditional and neotraditional solutions. In: E. Sills and K.L. Abt (Eds.) *Forests in a market economy*. Dordrecht, Netherlands: Kluwer Academic Publishers.

Cubbage, F.W.; Snider, A.; Abt, K.L. and Moulton, R.J. 2003. Chapter 3:  private forests:  management and policy in a market economy. In: E. Sills and K.L. Abt (Eds.) *Forests in a market economy*. Dordrecht, Netherlands: Kluwer Academic Publishers.

Holmes, T.P.; Prestemon, J.P.; Pye, J.M.; Butry, D.T.; Mercer, D.E. and Abt, K.L. 2003. Using size-frequency distributions to analyze fire regimes in Florida. *Fire in temperate, boreal and montane ecosystems, Proceedings of the Tall Timbers 22nd Fire Ecology Conference*. Kananaskis Village, Alberta, Canada, October 15-18, 2001.

Pattanayak, S.; Abt, K.L. and Holmes, T.P. 2003. Chapter 14:  timber and amenities on nonindustrial private forest land. In: E. Sills and K.L. Abt (Eds.) *Forests in a market economy*. Dordrecht, Netherlands: Kluwer Academic Publishers.

Pye, J.M.; Prestemon, J.P.; Butry, D.T. and Abt, K.L. 2003. Prescribed burning and wildfire risk in the 1998 fire season in Florida. *Fire, fuel treatments, and ecological restoration:  conference proceedings*. Fort Collins, CO.

Sills, E. and Abt, K.L. 2003. *Forests in a market economy*. Dordrecht, Netherlands: Kluwer Academic Publishers.
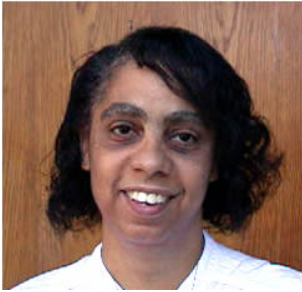
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### Education

Attended University of Maryland, 1973-1976 (Accounting)

### Experience

Project Secretary, USDA Forest Service, Economics of Forest Protection and Management, Research Triangle Park, North Carolina, 2000-present

Executive Assistant, USDA Forest Service, Regional Forester's Office, Alaska Region, Juneau, Alaska, 1990-2000
Administrative Support Assistant, USDA Office of the General Counsel, Alaska Region, Juneau, Alaska, 1988-1990

Accounting Technician, US Department of the Navy, Naval Medical Center National Capital Region, Comptroller Division, Bethesda, Maryland, 1985-1988

Military Personnel Clerk, US Department of the Army, Civilian Personnel Office, Baumholder, West Germany and Fort Riley, Kansas, 1983-1985


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### Education

Ph.D. North Carolina State University, 2001-present (Economics)

M.E.M. Duke University, 1999 (Resource Economics and Policy)

B.A. State University of New York at Buffalo, 1996 (Political Science)

### Experience

Economist, USDA Forest Service, Southern Research Station, Research Triangle Park, NC, November, 1999-present

Research Consultant, USDA Forest Service, Southern Research Station, Research Triangle Park, NC, August 1999-November 1999

Water Quality Policy Analyst, South Carolina Coastal Conservation League, Charleston, SC, Summer 1998

Legislative Assistant, New York State Senate, Albany, NY, Spring 1995

## Academic Experience

Teaching Assistant, Statistics, Duke University, Durham, NC, Spring 1999

## Recent Publications

### 2000   (1)

Butry, D. and Pattanayak, S. 2000. Welfare implications of tropical forest conservation: the case of Ruteng Park. *Proceedings of the 1999 Southern Forest Economics Workshop.* Starkville, MS, 2000.

### 2001   (2)

Butry, D.T.; Mercer, D.E.; Prestemon, J.P.; Pye, J.M. and Holmes, T.P. 2001. What is the price of catastrophic wildfire? *Journal of Forestry* 99(11):9-17.

Prestemon, J.P.; Mercer, D.E.; Pye, J.M.; Butry, D.T.; Holmes, T.P. and Abt, K.L. 2001. Economically optimal wildfire intervention regimes. *Proceedings, American Agricultural Economics Association Annual Meeting.* Chicago, IL, 2001.

### 2002   (3)

Butry, D.T.; Pye, J.M. and Prestemon, J.P. 2002. Prescribed fire in the interface: separating the people from the trees. In: K.W. Outcalt (Ed.) *Proceedings of the eleventh biennial southern silvicultural research conference.* Knoxville, TN: U.S. Department of Agriculture, Forest Service, Southern Research Station.

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Holmes, T.P.; Prestemon, J.P.; Pye, J.M.; Butry, D.T.; Mercer, D.E. and Abt, K.L. 2003. Using size-frequency distributions to analyze fire regimes in Florida. *Fire in temperate, boreal and montane ecosystems, Proceedings of the Tall Timbers 22nd Fire Ecology Conference.* Kananaskis Village, Alberta, Canada, October 15-18, 2001.

Pattanayak, S. and Butry, D.T. 2003. Chapter 20: forest ecosystem services as production inputs. In: E. Sills and K.L. Abt (Eds.) *Forests in a market economy.* Dordrecht, Netherlands: Kluwer Academic Publishers.

Pye, J.M.; Prestemon, J.P.; Butry, D.T. and Abt, K.L. 2003. Prescribed burning and wildfire risk in the 1998 fire season in Florida. *Fire, fuel treatments, and ecological restoration: conference proceedings.* Fort Collins, CO.

# Thomas P. Holmes

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## Education

Ph.D. University of Connecticut, 1986 (Agricultural and Natural Resource Economics)

M.S. University of Connecticut, 1979 (Agricultural Economics)

B.S. Ohio Wesleyan University, 1973 (Economics)

## Professional Experience

Research Forest Economist, USDA Forest Service, Southern Research Station, Research Triangle Park, NC 1988-present

Agricultural Economist, Economic Research Service, U.S. Department of Agriculture, Washington DC 1986-1988

## Academic Experience

Adjunct Professor of Resource Economics, Duke University, 1993-present

Adjunct Assistant Professor of Forest Economics, North Carolina State University, 1991-present

## Recent Publications

### 1998   (1)

Pendleton, L.; Sohngen, B.; Mendelsohn, R. and Holmes, T. 1998. Measuring environmental quality in the Southern Appalachian Mountains. *Forest Science* 44(4):603-609.

### 1999   (5)

Aldy, J.E.; Kramer, R.A. and Holmes, T.P. 1999. Environmental equity and the conservation of unique ecosystems: an analysis of the distribution of benefits for protecting Southern Appalachian spruce-fir forests. *Society and Natural Resources* 12:93-106.

Boltz, F.; Holmes, T.P. and Carter, D.R. 1999. The economics of reduced impact logging in the American tropics: a review of recent initiatives. *Proceedings of the 1998 Southern Forest Economics Workshop*. Research Triangle Park, NC, 1999.

Reaves, D.W.; Kramer, R.A. and Holmes, T.P. 1999. Does question format matter? Valuing an endangered species. *Environmental and Resource Economics* 14:365-383.

Schaberg, R.H.; Holmes, T.P.; Lee, K.J. and Abt, R.C. 1999. Ascribing value to ecological process: an economic view of environmental change. *Forest Ecology and Management* 114:329-338.

Wagner, J.E. and Holmes, T.P. 1999. Estimating economic gains for landowners due to time-dependent changes in biotechnology *Forest Science* 45(2):163-170.

### 2000   (4)

Ahn, S.; de Steiguer, J.E.; Palmquist, R.B. and Holmes, T.P. 2000. Economic analysis of the potential impact of climate change on recreational trout fishing in the Southern Appalachian Mountains: an application of a nested multinomial logit model. *Climate Change* 45:493-509.

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Holmes, T.P.; Blate, G.M.; Zweede, J.C.; Pereira, R., Jr.; Barreto, P.; Boltz, F. and Bauch, R. 2000. *Financial costs and benefits of reduced impact logging relative to conventional logging in the Eastern Amazon*. Washington, D.C.: Tropical Forest Foundation.

Prestemon, J.P. and Holmes, T.P. 2000. Timber price dynamics following a natural catastrophe. *American Journal of Agricultural Economics* 82:145-160.

### 2001   (7)

Boltz, F.; Carter, D.R.; Holmes, T.P. and Pereira, R., Jr. 2001. Financial returns under uncertainty for conventional and reduced-impact logging in permanent production forests of the Brazilian Amazon. *Ecological Economics* 39:387-398.

Boyle, K.J.; Holmes, T.P.; Teisl, M.F. and Roe, B. 2001. A comparison of conjoint analysis response formats. *American Journal of Agricultural Economics* 83(2):441-454.

Butry, D.T.; Mercer, D.E.; Prestemon, J.P.; Pye, J.M. and Holmes, T.P. 2001. What is the price of catastrophic wildfire? *Journal of Forestry* 99(11):9-17.

Holmes, T.P.; Boltz, F. and Carter, D.F. 2001. Financial indicators of reduced impact logging performance in Brazil: case study comparisons. Kuching, Sarawak, Malaysia, 2001.

Moffat, S.O.; Cubbage, F.W.; Holmes, T.P. and O'Sullivan, E. 2001. Characterizing the sustainable forestry issue network in the United States. *Forest Policy and Economics* 2(3-4):307-318.

Prestemon, J.P.; Mercer, D.E.; Pye, J.M.; Butry, D.T.; Holmes, T.P. and Abt, K.L. 2001. Economically optimal wildfire intervention regimes. *Proceedings, American Agricultural Economics Association Annual Meeting*. Chicago, IL, 2001.

Prestemon, J.P.; Pye, J.M. and Holmes, T.P. 2001. Timber economics of natural catastrophes. *Proceedings of the 2000 Southern Forest Economics Workshop*. Monticello, Arkansas, 2001.

## 2002   (7)

Boltz, F.; Holmes, T.P. and Carter, D.R. 2002. Economic and environmental impacts of conventional and reduced-impact logging in Tropical South America:  a comparative review. *Forest Policy and Economics* 5:69-81.

Holmes, T.; Boyle, K.J.; Teisl, M.F. and Roe, B. 2002. A comparison of conjoint analysis response formats: reply. *American Agricultural Economics Association* 84(4):1172-1175.

Holmes, T.P. 2002. Chapter 12:  forests and the quality of life. In: D.N. Wear and J.G. Greis (Eds.) *Southern Forest Resource Assessment*. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station.

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Holmes, T.P.; Blate, G.M.; Zweede, J.C.A.; Pereira, R., Jr.; Barreto, P. and Boltz, F. 2002. Custos e beneficios financeiros da exploracao florestal de impacto reduzido em comparacao a exploracao florestal convencional na Amazonia Oriental. Belem, Brazil: Fundacao Floresta Tropical.

Holmes, T.P.; Boltz, F. and Carter, D.R. 2002. Chapter 15:  financial indicators of reduced impact logging performance in Brazil:  case study comparisons. *Asia-Pacific Forestry Commission International Conference Proceedings*. Kuching, Malaysia.

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## 2003   (9)

Englin, J.; Holmes, T. and Neill, R. 2003. Alternative systems of semi-logarithmic incomplete demand equations : modeling recreational off-highway vehicle site demand. *Proceedings of the 2003 W-133 Conference, Estimating Benefits and Costs in Natural Resource Management*. Reno, NV.

Englin, J.E.; Holmes, T.P. and Sills, E. 2003. Chapter 19:  estimating forest recreation demand using count data models. In: E. Sills and K.L. Abt (Eds.) *Forests in a market economy*. Dordrecht, Netherlands: Kluwer Academic Publishers.

Holmes, T.P. and Adamowicz, W.L. 2003. Attribute-based methods. In: P. Champ, K. Boyle and  T. Brown (Eds.) *A Primer on Non-market Valuation*: Kluwer Academic Publishers.

Holmes, T.P. and Boyle, K.J. 2003. Chapter 18:  stated preference methods for valuation of forest attributes. In: E. Sills and K.L. Abt (Eds.) *Forests in a market economy*. Dordrecht, Netherlands: Kluwer Academic Publishers.

Holmes, T.P.; Prestemon, J.P.; Pye, J.M.; Butry, D.T.; Mercer, D.E. and Abt, K.L. 2003. Using size-frequency distributions to analyze fire regimes in Florida. *Fire in temperate, boreal and montane ecosystems, Proceedings of the Tall Timbers 22nd Fire Ecology Conference*. Kananaskis Village, Alberta, Canada, October 15-18, 2001.

Kramer, R.A.; Holmes, T.P. and Haefele, M. 2003. Chapter 17:  contingent valuation of forest ecosystem protection. In: E. Sills and K.L. Abt (Eds.) *Forests in a market economy*. Dordrecht, Netherlands: Kluwer Academic Publishers.

Pattanayak, S.; Abt, K.L. and Holmes, T.P. 2003. Chapter 14:  timber and amenities on nonindustrial private forest land. In: E. Sills and K.L. Abt (Eds.) *Forests in a market economy*. Dordrecht, Netherlands: Kluwer Academic Publishers.

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Sills, E.; Lele, S.; Holmes, T.P. and Pattanayak, S. 2003. Chapter 15: nontimber forest products in the rural household economy. In: E. Sills and K.L. Abt (Eds.) *Forests in a market economy*. Dordrecht, Netherlands: Kluwer Academic Publishers.

### *In press        (2)*

Prestemon, J.P. and Holmes, T.P. in press. Market dynamics and optimal timber salvage after a natural catastrophe. *Forest Science.*

Holmes, T.P.; Bergstrom, J.C; Huszar, E.; Kask, S.B. and Orr, F. in press. Contingent valuation, net marginal benefits, and the scale of riparian ecosystem restoration. *Ecological Economics.*

# D. Evan Mercer

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## Education

PhD, Natural Resource Economics: Duke University, Durham, NC. 1991

MS, Forest Ecology: University of Michigan, Ann Arbor. 1984

BS, Biology & BS, Zoology: University of Texas at Austin. 1980

Organization of Tropical Studies: Tropical Ecology. Universidad de Costa Rica, San Jose. 1982

Marine Biological Laboratory: Marine Ecology. Wood's Hole, Massachusetts. 1979

## Professional Experience

Research Economist. Southern Research Station. U.S.D.A. Forest Service. Research Triangle Park, NC. Conduct research on forest resource economic and policy problems. 1992-present.

Adjunct Associate Professor of Resource Economics. School of the Environment Duke University, Durham, North Carolina. 1994-present.

Adjunct Assistant Professor of Forest Economics. College of Natural Resources. North Carolina State University, Raleigh, North Carolina. 1994-present.

Research Scientist. Center for Resource and Environmental Policy Research. Duke University. Conducted research studies to estimate the benefits accruable to tropical forest preservation in Madagascar. 1991-1992.

Economist. Center for Economics Research, Research Triangle Institute, Research Triangle Park, North Carolina. Performed economic analysis of natural resource and environmental policy problems. 1990-91.

Research Intern. Environment and Policy Institute, East-West Center, Honolulu. 1983-1986.

## Recent Publications

### 1999    (4)

Aruna, P.B. and Mercer, D.E. 1999. The timber economy of the Mid-Atlantic Region: some preliminary results from the Mid-Atlantic Integrated Assessment. *Proceedings of the 1998 Southern Forest Economics Workshop*. Research Triangle Park, NC, 1999.

Casey, J.; Mercer, E. and Snook, A. 1999. Evaluating farmer preferences for agroforestry systems: survey instrument design. Research Triangle Park, NC, 1999.

Mercer, E.; Thompson, A. and Flemming, G. 1999. Eco-tourism in the Blue and John Crow Mountains National Park of Jamaica, West Indies: Chapter 4. Economic demand for ecotourism development. Greensboro, NC: North Carolina AandT State University School of Agriculture.

Thompson, A.; Mercer, E. and Alston, A. 1999. Eco-tourism in the Blue and John Crow Mountains National Park of Jamaica, West Indies: Chapter III Planning for ecotourism in communities surrounding the BCandJCM National Park. Greensboro, NC: North Carolina AandT State University School of Agriculture.

### 2000    (2)

Casey, J.; Mercer, E. and Snook, A. 2000. Agroforestry adoption: Keynes' "animal spirits" are alive and well in the Yucatan. *Proceedings of the 1999 Southern Forest Economics Workshop*. Starkville, MS, 2000.

Mercer, E. and Aruna, P.B. 2000. Assessing the impacts of forests on human welfare: preliminary results from the Mid-Atlantic Integrated Assessment. *Environmental Monitoring and Assessment* 63:43-63.

### 2001    (2)

Butry, D.T.; Mercer, D.E.; Prestemon, J.P.; Pye, J.M. and Holmes, T.P. 2001. What is the price of catastrophic wildfire? *Journal of Forestry* 99(11):9-17.

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### 2002    (6)

Kramer, R. 2002. Wetland restoration choice behavior of landowners: the influence of program attributes. *Proceedings of the 2002 Southern Forest Economics Workshop*, March 17-19, 2002.

Pattanayak, S.K. and Mercer, D.E. 2002. Indexing soil conservation: farmer perceptions of agroforestry benefits. *Journal of Sustainable Forestry* 15(2):63-85.

Pattanayak, S.K.; Mercer, D.E.; Sills, E.O. and Cassingham, K. 2002. Adopting agroforestry. *Proceedings of the 2001 Southern Forest Economics Workshop*. Auburn, AL, 2002.

Prestemon, J.P.; Pye, J.M.; Butry, D.T.; Holmes, T.P. and Mercer, D.E. 2002. Understanding broadscale wildfire risks in a human-dominated landscape. *Forest Science* 48(4):685-693.

### 2003    (3)

Holmes, T.P.; Prestemon, J.P.; Pye, J.M.; Butry, D.T.; Mercer, D.E. and Abt, K.L. 2003. Using size-frequency distributions to analyze fire regimes in Florida. *Fire in temperate, boreal and montane ecosystems, Proceedings of the Tall Timbers 22nd Fire Ecology Conference*. Kananaskis Village, Alberta, Canada, October 15-18, 2001.

Mercer, D.E. and Pattanayak, S. 2003. Chapter 16:  agroforestry adoption by smallholders. In: E. Sills and K.L. Abt (Eds.) *Forests in a market economy*. Dordrecht, Netherlands: Kluwer Academic Publishers.

Pattanayak, S.K.; Mercer, D.E.; Sills, E. and Yang, J.-C. 2003. Taking stock of agroforestry adoption studies. *Agroforestry Systems* 57:173-186.

### In press       (7)

Donoghue, E.M.; Cubbage, F.W. & Mercer, D.E. in press. Contract NGO's in community-based forest management in the Philippines. *Journal of Sustainable Forestry*.

Mercer, D.E. in press. Policies for encouraging forest restoration. In: J. Stanturf & P. Madsen (Eds.) *Restoration of Boreal and Temperate Forests*: CRC Press.

Mercer, E. in press. Adoption of agroforestry innovations: a review. *Agroforestry Systems*.

Mercer, E.; Haggar, J.; Snook, A. & Sosa, M. in press. Agroforestry adoption in the Calakmul Biosphere Reserve, Campeche, Mexico. *Journal of Crop Production*.

Mercer, E. & Murthy, A. in press. Socio-economic issues in the MAIA region. In: K.W. Stolte; B.L. Conkling & S. Fulton (Eds.) *General Technical Report*. Asheville, NC: USDA Forest Service, Southern Research Station.

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# Jeffrey P. Prestemon

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## Education

Ph.D. University of Wisconsin-Madison, 1994 (Forest Economics)

M.S. North Carolina State University, 1989 (Forest Economics)

B.S. Iowa State University, 1983 (Forest Resource Management)

## Experience

Research Forest Economist, USDA Forest Service, Southern Research Station, Research Triangle Park, NC 1995-present

Adjunct Assistant Professor, Department of Forestry, North Carolina State University, 2000-present

Editorial Board Member, Forest Policy and Economics, 2002-present

Research Associate, Department of Forestry, University of Wisconsin-Madison, 1994-1995

Research Assistant, Department of Forestry, University of Wisconsin-Madison, 1991-1994

Research Forest Economist, Forestry Private Enterprise Initiative, North Carolina State University, Raleigh 1989-1990

Research Assistant, Department of Forestry, North Carolina State University, 1987-1988

Volunteer, U.S. Peace Corps, Honduras, Watershed Management and Forestry 1984-1986

Analyst, Industrial Forestry Association, Lacy, Washington, 1983-1984

Forest Genetics Research Technician, Department of Forestry, Iowa State University, Ames, Iowa, 1983

Laboratory Technician, Department of Plant Pathology, Iowa State University, Ames, Iowa, 1981-1983

## Recent Publications

### 1999   (2)

Bingham, M.; MacNair, D. and Prestemon, J. 1999. Structural change and co-integration in southern timber prices. *Proceedings of the 1998 Southern Forest Economics Workshop*. Research Triangle Park, NC, 1999.

Prestemon, J.P. and Wear, D.N. 1999. Inventory effects on aggregate timber supply. *Proceedings of the 1998 Southern Forest Economics Workshop*. Research Triangle Park, NC, 1999.

### 2000   (9)

Prestemon, J.P. 2000. Public open access and private timber harvests: theory and application to the effects of trade liberalization in Mexico. *Environmental and Resource Economics* 17:311-334.

Prestemon, J.P. and Buongiorno, J. 2000. Determinants of tree quality and lumber value in natural uneven-aged southern pine stands. *Canadian Journal of Forest Research* 30(2):211-219.

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Prestemon, J.P.; Pye, J.M.; Abt, K.L.; Wear, D.N. and LeDoux, C. 2000. Market definition for hardwood timber in the Southern Appalachians. *Proceedings of the 1999 Southern Forest Economics Workshop*. Starkville, MS, 2000.

Prestemon, J.P. and Wear, D.N. 2000. Linking harvest choices to timber supply. *Forest Science* 46(3):377-389.

Raunikar, R.; Buongiorno, J.; Prestemon, J. and Abt, K.L. 2000. Biological and economic productivity of mixed-aged loblolly pine stands in the South. *Proceedings of the 1999 Southern Forest Economics Workshop*. Starkville, MS, 2000.

Raunikar, R.; Buongiorno, J.; Prestemon, J.P. and Abt, K.L. 2000. Financial performance of mixed-age naturally regenerated loblolly-hardwood stands in the South Central United States. *Forest Policy and Economics* 1(3/4):331-346.

### 2001   (3)

Butry, D.T.; Mercer, D.E.; Prestemon, J.P.; Pye, J.M. and Holmes, T.P. 2001. What is the price of catastrophic wildfire? *Journal of Forestry* 99(11):9-17.

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Prestemon, J.P.; Pye, J.M. and Holmes, T.P. 2001. Timber economics of natural catastrophes. *Proceedings of the 2000 Southern Forest Economics Workshop*. Monticello, Arkansas, 2001.

### 2002   (6)

Butry, D.T.; Pye, J.M. and Prestemon, J.P. 2002. Prescribed fire in the interface: separating the people from the trees. In: K.W. Outcalt (Ed.) *Proceedings of the eleventh biennial southern silvicultural research conference*. Knoxville, TN: U.S. Department of Agriculture, Forest Service, Southern Research Station.

Luppold, W.G.; Prestemon, J.P. and Schuler, A. 2002. Changing markets for hardwood roundwood. *Proceedings of the 2001 Southern Forest Economics Workshop*. Auburn, AL, 2002.

Prestemon, J.P. and Abt, R.C. 2002. The southern timber market to 2040. *Journal of Forestry* 100(7):16-22.

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Prestemon, J.P.; Pye, J.M.; Butry, D.T.; Holmes, T.P. and Mercer, D.E. 2002. Understanding broadscale wildfire risks in a human-dominated landscape. *Forest Science* 48(4):685-693.

## 2003   (10)

Abt, K.L. and Prestemon, J.P. 2003. Chapter 4:  optimal stand management:  traditional and neotraditional solutions. In: E. Sills and K.L. Abt (Eds.) *Forests in a market economy*. Dordrecht, Netherlands: Kluwer Academic Publishers.

Bingham, M.F.; Prestemon, J.P.; MacNair, D.J. and Abt, R.C. 2003. Market structure in U.S. southern pine roundwood. *Journal of Forest Economics* 9(2):97-117.

Holmes, T.P.; Prestemon, J.P.; Pye, J.M.; Butry, D.T.; Mercer, D.E. and Abt, K.L. 2003. Using size-frequency distributions to analyze fire regimes in Florida. *Fire in temperate, boreal and montane ecosystems, Proceedings of the Tall Timbers 22nd Fire Ecology Conference*. Kananaskis Village, Alberta, Canada, October 15-18, 2001.

Luppold, W.G. and Prestemon, J.P. 2003. Are prices of hardwood lumber interrelated or independent? *Forest Science* 49(6).

Murray, B.C. and Prestemon, J.P. 2003. Chapter 10:  structure and efficiency of timber markets. In: E. Sills and K.L. Abt (Eds.) *Forests in a market economy*. Dordrecht, Netherlands: Kluwer Academic Publisher.

Prestemon, J.P. 2003. Evaluation of U.S. southern pine stumpage market informational efficiency. *Canadian Journal of Forest Research* 33(4):561-572.

Prestemon, J.P.; Buongiorno, J.; Wear, D.N. and Siry, J.P. 2003. Chapter 11:  international trade in forest products. In: E. Sills and K.L. Abt (Eds.) *Forests in a market economy*. Dordrecht, Netherlands: Kluwer Academic Publishers.

Prestemon, J.P.; Pye, J.M. and Holmes, T.P. 2004. Temporal aggregation and testing for timber price behavior. *Natural Resource Modeling* 17(1).

Pye, J.M.; Prestemon, J.P.; Butry, D.T. and Abt, K.L. 2003. Prescribed burning and wildfire risk in the 1998 fire season in Florida. *Fire, fuel treatments, and ecological restoration:  conference proceedings*. Fort Collins, CO.

Rummer, B.; Prestemon, J.P.; May, D.; Miles, P.; Vissage, J.S.; McRoberts, R.E.; Liknes, G.; Shepperd, W.D.; Ferguson, D.; Elliot, W.; Miller, S.; Reutebuch, S.E.; Barbour, J.; Fried, J.; Stokes, B.; Bilek, E.; Skog, K. and Hartsough, B. 2003. A strategic assessment of forest biomass and fuel reduction treatments in western states.

## in press        (3)

Nagubadi, V.; Zhang, D.; Prestemon, J.P. and Wear, D.N. in press. Softwood lumber products in the United States: substitutes or complements? *Forest Science*.

Prestemon, J.P. and Holmes, T.P. in press. Market dynamics and optimal timber salvage after a natural catastrophe. *Forest Science*.

Wear, D.N. and Prestemon, J.P. in press. Timber market research, private forests, and policy rhetoric. In: M. Rauscher; K. Johnsen and R. Doudrick (Eds.) *Southern Forest Science: Past, Present, Future*.

## John M. Pye

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## Education

---- Duke University, 1985 doctoral candidate, Forest Ecology

M.A. University of North Carolina-Chapel Hill, 1983 (Ecology with Economics minor)

B.A. Swarthmore College, 1976 (Biology)

## Experience

Webmaster, USDA Forest Service, Economics of Forest Protection and Management, Research Triangle Park, NC. 1996-present

Ecologist, USDA Forest Service, Economics of Forest Protection and Management, Research Triangle Park, NC. 1991-present

Ecologist, USDA Forest Service, Pest Impact Assessment Technology, Research Triangle Park, NC. 1985-1991

Continuing Education Instructor (computing), Durham Tech. Community College, Durham NC and freelance 1991- present

Consultant, Carolina Environmental Consultants, Chapel Hill NC. 1985

Research Assistant, Dept. of Pathology, North Carolina State Univ., Raleigh, NC. 1984

Graduate Research Assistant, Duke University and University of North Carolina - Chapel Hill. 1981-1985

Research Analyst and Consultant, Macro Systems, Silver Spring, MD. 1976-1979

## Skills

HTML, SAS, Windows, TCP/IP, Unix, ArcView, ArcInfo

English mostly, some Portuguese and German

Backpacking, dog training

## Memberships

Ecological Society of America

Society of American Foresters

International Association for Landscape Ecology, US Regional Association

## Recent Publications

### 2000   (5)

Cubbage, F.W.; Pye, J.M.; Holmes, T.P. and Wagner, J.E. 2000. An economic evaluation of fusiform rust protection research. *Southern Journal of Applied Forestry* 24(2):77-85.

Gumpertz, M.L.; Wu, C.-T. and Pye, J.M. 2000. Logistic regression for southern pine beetle outbreaks with spatial and temporal autocorrelation. *Forest Science* 46(1):95-107.

Prestemon, J.P. and Pye, J.M. 2000. A technique for merging areas in Timber Mart-South data *Southern Journal of Applied Forestry* 24(4):219-229.

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### 2001   (3)

Butry, D.T.; Mercer, D.E.; Prestemon, J.P.; Pye, J.M. and Holmes, T.P. 2001. What is the price of catastrophic wildfire? *Journal of Forestry* 99(11):9-17.

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Prestemon, J.P.; Pye, J.M. and Holmes, T.P. 2001. Timber economics of natural catastrophes. *Proceedings of the 2000 Southern Forest Economics Workshop*. Monticello, Arkansas, 2001.

## 2002 (3)

Butry, D.T.; Pye, J.M. and Prestemon, J.P. 2002. Prescribed fire in the interface: separating the people from the trees. In: K.W. Outcalt (Ed.) *Proceedings of the eleventh biennial southern silvicultural research conference*. Knoxville, TN: U.S. Department of Agriculture, Forest Service, Southern Research Station.

Prestemon, J.P.; Pye, J.M.; Butry, D.T.; Holmes, T.P. and Mercer, D.E. 2002. Understanding broadscale wildfire risks in a human-dominated landscape. *Forest Science* 48(4):685-693.

## 2003 (3)

Holmes, T.P.; Prestemon, J.P.; Pye, J.M.; Butry, D.T.; Mercer, D.E. and Abt, K.L. 2003. Using size-frequency distributions to analyze fire regimes in Florida. *Fire in temperate, boreal and montane ecosystems, Proceedings of the Tall Timbers 22nd Fire Ecology Conference*. Kananaskis Village, Alberta, Canada, October 15-18, 2001.

Prestemon, J.P.; Pye, J.M. and Holmes, T.P. 2004. Temporal aggregation and testing for timber price behavior. *Natural Resource Modeling* 17(1).

Pye, J.M.; Prestemon, J.P.; Butry, D.T. and Abt, K.L. 2003. Prescribed burning and wildfire risk in the 1998 fire season in Florida. *Fire, fuel treatments, and ecological restoration: conference proceedings*. Fort Collins, CO.

# Research Productivity

## Publications

Since FY1999, scientists in the work unit have produced 181 publications (~ 33 per year). About 44 percent of these have been published in refereed journals (~14 per year).
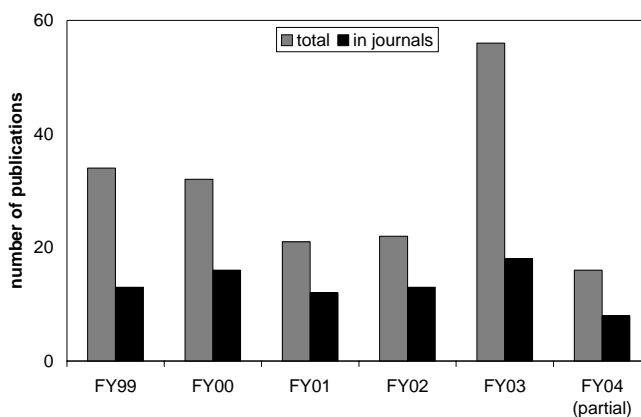


Research findings have appeared in 35 different journals including:

| | |
|---|---|
| *Forest Science* | *Journal of Forestry* |
| *Canadian Journal of Forest Research* | *Land Economics* |
| *American Journal of Agricultural Economics* | *Ecological Economics* |
| *Southern Journal of Applied Forestry* | *Landscape Ecology* |
| *Journal of Environ. Economics & Management* | *Ecosystems* |
| *The American Statistician* | *Natural Resource Modeling* |
| *International Journal of Wildland Fire* | *Journal of Forest Economics* |
| *Forest Products Journal* | *Science* |

# Presentations

Since 1998, scientists in the work unit have given 114 presentations (~ 23 per annum) at scientific and professional meetings, including those listed below.
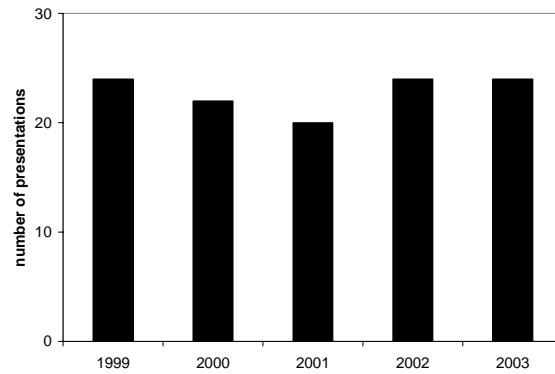


| | |
|---|---|
| Southern Forest Economics Workshops (1999-2003) | Southern Group of State Foresters Annual Meeting |
| International Conference on the Application of Reduced Impact Logging | Perspectives on sustainable forestry for the South: A Southwide Regional Forestry Forum |
| Southern Appalachian Man and the Biosphere Conference | Southern Forest Science Conference |
| Economic and Policy Solutions for Ecosystem Conservation Course | Workshop on Effective Use of Ecological Modeling in Management, Oak Ridge National Laboratories |
| Wildland-Urban Interface Conference | Western Forest Economists Annual Meeting |
| National Science Foundation Workshop: "Alternatives to Contingent Valuation in Environmental Valuation", | Conference of Latin Americanist Geographers 2000 Meeting. |
| 2nd World Congress of Environmental and Resource Economists | Duke University, Forum: Seeing the Forest through the Trees: The future of forestry and foresters. |
| 22nd Tall Timbers Fire Ecology Conference | Future of Forest Industry in Texas |
| Southern Hardwood Forest Research Group Meeting, | Commissioner of Agriculture's 2003 Forestry Forum |
| W-133 Regional Project, Benefits and Costs in Natural Resource Planning | USDA Symposium on Natural Resource Management to Offset Greenhouse Gas Emissions |
| 75th Annual Western Economics Association International Conference | University of Michigan Distinguished Speaker Series, Ecosystem Management Initiative |
| Association of State Wetlands Managers | Michigan State University |
| Society of American Foresters 2002 Convention | Auburn University, Weaver Lecture |
| Annual meeting of the Texas Forestry Association | Annual Hardwood Symposium |
| Southern Group of State Foresters | Midwest Forest Economists Meeting |
| Annual Meeting of the Entomological Society of America | Fire Science and Fire Management in Southern Forests |
| Forest Fragmentation Conference: the Chesapeake Bay Watershed | Fire Conference 2000: The First National Congress on Fire Ecology, Prevention, and Management |
| 9th U.S./Mexico Border States Conference on Recreation Parks and Wildlife.  University of Arizona | NASA-funded workshop on Land Use Changes in Rural America |
| North American Wildlife and Natural Resource Conference | Sustaining Southern Forests: the Science of Forest Assessment |
| Florida Forestry Association. September 5, 2001 | Southern Forest Service Webmaster Meeting |
| Forest Forever or Forest Fragmentation. the Western Virginia Land Trust | Conference on Fire, Fuel Treatments and Ecological Restoration |
| The Annual Society of American Foresters Convention | Symposium on Systems Analysis in Forest Resources |
| European Association of Environmental and Resource Economists Annual Conference | Annual Meeting of the American Agricultural Economics Association |
| 53rd Annual Southeastern Association of Fish and Wildlife Agencies | Seminar series, Kellogg School of Management, Northwestern University |
| NSF-funded workshop on Ecological Forecasting, National Center for Ecological Analysis and Synthesis. | Southern Appalachian Man and the Biosphere 11th Annual conference |
| International Social Science Research Meeting | Human Dimensions in the West |
| 2nd International Conference on Wildland Fire Ecology and Management Congress | 11th Biennial Southern Silvicultural Research Conference |
| Association of Southeastern Biologists | Small Diameter Timber Workshop |
| Weyerhaeuser External Affairs Council | World Conference on Natural Resource Modeling |

# Participation

In addition to the standard outlets for reporting scientific findings, researchers in the work unit have lent their expertise to several organizations and projects. This participation in solving resource problems takes many forms, ranging from brief consultations with a research customer to a special assignment with a regional resource assessment. A list of these activities since 1993 follows.

## Consultations

| **U.S. Forest Service** |
|---|
| National Forest System Region 8 |
| State and Private Forestry Region 8 |
| Lolo, Bitterroot and Siskiyou National Forests |
| International Programs |
| Center for Semiarid Agroforestry |
| Forest Health Monitoring |
| Forest Pest Management |
| State and Private Forestry |
| |
| **Other U.S. Federal Agencies** |
| Department of Interior |
| Environmental Protection Agency |
| USDI Fish and Wildlife Service |
| USDA National Agroforestry Center |
| USDA Office of Global Change |
| U.S. Man and the Biosphere Program |
| |
| **Foreign Governmental Agencies** |
| Brazilian Institute for the Environment (IBAMA) |
| Brazilian Agricultural Research Institute (EMBRAPA) |
| Forestry Canada |
| |
| **State Governments** |
| Southern Group of State Foresters |
| Florida Dept. of Agriculture and Conservation Services |
| Virginia Department of Forestry |
| Testimony for Tennessee Legislature |
| Testimony for Virginia Legislature |
| |
| **Private Industry** |
| Orbis GIS |
| Paul Renfroe, CSA |
| Forest Investment Associates |
| |
| **Non-governmental Organizations** |
| The Nature Conservancy |
| Society of American Foresters |
| Conservation International |

| |
|---|
| Chesapeake Bay Foundation |
| Association of Temperate Agroforestry |
| World Agroforestry Centre |
| Center for Sub-Tropical Agroforestry |
| Bharathidasan University, Truchirappalli, India |

## Professional Service

| **Journals** |
|---|
| Associate Editor, *Southern Journal of Applied Forestry* (Wear) |
| Associate Editor, *Ecosystems* (Wear) |
| Associate Editor, *American Journal of Agricultural Economics* (Wear) |
| Associate Editor, *Forest Policy and Economics* (Prestemon) |
| Guest Associate Editor, *Forest Science* (Prestemon) |
| Guest Associate Editor, *Natural Resource Modeling* (Prestemon) |
| Associate Editor, *Agroforestry Systems* (Mercer) |
| **Professional Groups** |
| Deputy Coordinator, Socio-Economics, Agroforestry Research Group, IUFRO (Mercer) |
| Chair, Economics, Law, and Policy Working Group, Society of Amer. Foresters (Wear) |

## Accomplishment Report FY1999 to FY2003

This section reviews the accomplishments of SRS-4851 in each of the five Problem Areas under which the Unit operated since 1999. Key findings are presented for each of the study areas within each Problem Area along with discussion of their implications for future research.

# Problem Area 1 - Assessment of Southern Timber Markets

## Definition

Restrictions on the timber and wood products produced in other regions of the U.S. and imported from Canada have increased the demand for timber from the U.S. South. In the South, where private landowners produce nearly all timber, hardwood and softwood timber production has steadily increased over the past 40 years. As a result, the South has become the nation's most important wood-producing region and its market share continues to grow. At the same time, changes in the ownership profile of forest landowners imply changes in management objectives and timber supply. Increasing timber prices suggest an emerging scarcity of timber. A better understanding of the operation and potential future of timber markets in the South is needed to guide policy and investment decisions. Key research issues are the effects of land use on timber availability, the implications of forest landowners' decision-making on timber supply, the linkages between changing wood product markets, and scaling market analysis from local to regional to national applications. <u>Improve methods to evaluate the effects of changes in demand, product mix, and landowners on timber investment and markets in the South.</u>

## Study Areas

1. Effects of market structure on timber markets

2. Effects of owner, site, and forest heterogeneity on timber supplies

3. Spatial assessment of timber markets in the South

4. Evaluating forest investment and harvesting in a common analytical framework

## Accomplishments

Descriptions of research accomplishments are organized by the study areas listed above.

## Timber market structure

### Key Findings

Research examined market structures and challenged the "law of one price" for both timber and finished products. A series of studies confirms that both softwood and hardwood lumber markets support the Law of One Price (LOP). Although limited support exists for geographical subsets of the market, softwood and hardwood timber markets were found to not be perfectly integrated South-wide and hardwood lumber prices are not integrated across species within grades.

### Implications

These findings suggest that standard aggregate economic approaches to measuring the impacts of natural disasters are inadequate for evaluating effects on timber markets.

Findings also indicate that while timber markets are not integrated, they are linked in a systematic fashion that has yet to be discovered, possibly through integration in markets for products in higher stages of production (e.g., lumber, paper).

Hardwood markets for individual species are either independent or not related in any stable statistical fashion.

### New Questions

Why are timber markets not integrated? What are the roles of transportation and harvesting costs in integration, and are changes in those costs the reason for lack of integration? What are the implications for doing aggregate market analysis when the nonintegrated market for timber feeds an integrated final product output market?

What are the market implications of a shift in forestland ownership from forest industry to timber investment management organizations (TIMOs)?

Are hardwood markets integrated spatially within species and grades? In other words, are recent failures of the tests of the law of one price in south wide hardwood stumpage due to excessive aggregation across species and product qualities?

### Key Citations

1.  Luppold, W. G., J. P. Prestemon, and J. E. Baumgras. 1998. An examination of the relationships between hardwood lumber and stumpage prices in Ohio. Wood and Fiber Science 30(3):281-292.

2.  Nagubadi, V., I. A. Munn, and A. Tahai. 2001. Integration of hardwood stumpage markets in the Southcentral United States. Journal of Forest Economics 7(1):69-98.

3.  Prestemon, J. P. and T. P. Holmes. 2000. Timber price dynamics following a natural catastrophe. American Journal of Agricultural Economics 82:145-160.

4. Siry, J. P. and F. W. Cubbage. 2002. A survey of timberland investment management organizations forestland management in the South. Pages 153-156. In: Zhang, D. (ed.). Proceedings of the 2001 Southern Forest Economics Workshop. Auburn, AL: School of Forestry and Wildlife Sciences, Auburn University.

5. Bingham, M., J.P. Prestemon, D.J. MacNair, and R.C. Abt. 2003. Market structure in U.S. southern pine roundwood. Journal of Forest Economics 9(2):97-117.

6. Prestemon, J.P. 2003. Testing for timber market efficiency. Canadian Journal of Forest Research 33(4):561-572.

7. Prestemon, J.P., J.M. Pye, and T.P. Holmes. 2004. Temporal aggregation and testing for timber price behavior. Natural Resource Modeling 17(1).

## *Related Activities*

Research in this area laid the groundwork for our investigations into the market impacts of natural disasters such as hurricanes and fire. A presentation outlining the timber market price effects of Hurricane Hugo in South Carolina has been followed by ongoing work evaluating the aggregate timber market welfare impacts of this natural disaster; a manuscript is in process at Forest Science.

An outgrowth of our timber market research was the development of a set of timber price information pages on the world wide web. The pages direct visitors to free sources of timber and log prices on the Internet, state government contacts for additional information on timber prices and timber management, and timber price-related research that this unit has supported over the years. These pages are by far the most popular on the unit's website, itself the second most visited Unit web site in the Station.

Two Joint Fire Sciences Program funded studies by the Unit have quantified some of the timber market impacts of wildfire. The first, funded in 1999 and titled "The Ecological and Economic Impacts of the Florida 1998 Wildfires," led to a paper by Butry et al. (2001) highlighting the importance of timber market welfare losses caused by wildfire in places where timber is an important commodity. The second, funded in 2002 and titled "A National Study of the Economic Impacts of Biomass Removals to Mitigate Wildfire Damages on Federal, State, and Private Lands" will lead to a characterization of timber markets throughout the country. The tools developed from that research will be used to assess the aggregate impacts, by producer and consumer group, of large-scale programs to mitigate wildfire risk by removing marketable wood from fire-prone forests.

## Demographic and inventory effects on timber supplies

### Key findings

Local population density has a discernable impact on the propensity to manage forests for timber production.

Demographic characteristics, including age, income, bequest motives, and environmental preferences have discernable and predictable influence on management decisions including whether and how much timber to harvest and where or not to reforest.

Aggregate timber supply responses can be evaluated by examining individual supply responses that are a function of market variables as well as stand variables related to timber value, nontimber values, and site factors affecting harvesting costs. Timber supply responsiveness varies with all of these factors—site productivity, measures of nontimber values, and stand value growth.

Market spatial distribution affects management behavior (harvesting, pine plantation establishment), with harvesting propensity negatively related to distance to the nearest mill in most cases and pine plantation establishment probability negatively related to distance to the nearest pulp mill.

### Implications

Growing and changing populations in rural areas may have predictable implications for forest conditions and timber supplies.

The spatial distribution of the market and forest management activities are jointly related, although the direction of causality could not be established.

Aggregate timber supply models should account for aggregate measures of inventory vintage, site qualities, and timber value growth, and perhaps nontimber values.

### New questions

How do demographic, site, and timber vintage characteristics influence timber supply at a larger regional level?

Do forest conditions simultaneously influence demographics?

Can a cause-effect relation be established between harvesting and pine plantation establishment and distance to mill?

Are timber harvest choices independently related to mill distance or are they influenced by the contemporaneous harvest choices of neighboring forestland owners, and how does their spatial distribution affect timber supply responses to market shocks?

Is pine plantation establishment related to surrounding demographic characteristics?

**Key citations**

1. Fina, M., G. S. Amacher, and J. Sullivan. 2001. Uncertainty, debt, and forest harvesting: Faustmann revisited. Forest Science 47(2):188-196.

2. Wear, D. N., J. M. Foreman, and R. M. Sheffield. 1999. The effects of population growth on timber management and inventories in Virginia. Forest Ecology and Management 118:107-115.

3. Prestemon, J. P., J. M. Pye, K. L. Abt, D. N. Wear, and C. LeDoux. 2000. Market definition for hardwood timber in the Southern Appalachians. Pages 91-98. In: Munn, I. A., Bullard, S. H., Grado, S. C., and Grebner, D. L. (ed.). Proceedings of the 1999 Southern Forest Economics Workshop. Starkville, MS: Mississippi State University.

4. Prestemon, J. P. and D. N. Wear. 2000. Linking harvest choices to timber supply. Forest Science 46(3):377-389.

5. Abt, K.L., and J.P. Prestemon. 2003. "Optimal stand management: classical and neoclassical solutions." In Sills, E., and K.L. Abt (editors), Forests in a Market Economy, Amsterdam: Kluwer.

## Spatial assessment of timber markets in the South

### Key findings

Timber quality is related to tree age, site, and stand factors for most major softwood and hardwood species growing in the South, and these relationships vary geographically across the range of the species.

Federal land management policy related to endangered and threatened animal species in the Pacific Northwest has affected the degree of integration in lumber markets between western and southern lumber markets.

Federal land management policy related to endangered and threatened animal species in the Pacific Northwest has resulted in economic transfers across economic groups and regions in the U.S.

### Implications

Large changes in timber age distributions are likely to affect timber quality available for processing, which could serve as a motivation for technological change and product market shifts.

Large policy-induced inventory shocks in forest product markets have effects that are widely distributed.

Federal policies that set aside large parts of the public timber inventory can affect timber producers and consumers in local and distant markets. Whether intended or not, local and distant market effects should be accounted for when evaluating the costs and benefits of land management policies.

### New questions

How can spatial assessment findings be integrated with those from market structure research into a unified framework?

How are southern timber markets related to timber markets in other regions?

Do timber markets from other parts of the U.S. exhibit the same characteristics as Southern timber markets?

How do forest product imports from Canada and other regions affect timber owners and wood product producers in the South?

### Key citations

1. Prestemon, J. P. 1998. Estimating tree grades for Southern Appalachian natural forest stands. Forest Science 44(1):73-86.

2. Prestemon, J. P. and J. Buongiorno. 2000. Determinants of tree quality and lumber value in natural uneven-aged southern pine stands. Canadian Journal of Forest Research 30(2):211-219.

3.  Prestemon, J. P. and J. M. Pye. 2000. A technique for merging areas in Timber Mart-South data. Southern Journal of Applied Forestry 24(4):219-229.

4.  Murray, B. C. and D. N. Wear. 1998. Federal timber restrictions and interregional arbitrage in U.S. lumber. Land Economics 74(1):76-91

*Related activities*

A method for modifying Timber Mart South data to correct for changing aggregation practices over time was made available on our web site and is proving very popular among website visitors. This set of weights allows long run timber price trend analyses and related research into southern timber markets.

Mill maps for the eastern U.S. have been developed (J.P. Prestemon, J.M. Pye, D.T. Butry, D. Stratton) with assistance from various FIA units throughout the East. These are available to the public on the web and are very popular. The GIS coverages and associated attribute tables have been used by business to locate potential partners and clients, by university researchers to investigate spatial linkages in the industry, and within the unit to study timber harvest choices and timber market spatial structure, and to support the Southern Forest Resource Assessment.

## Joint analysis of forest investment and harvesting

### Key findings

A unified model of land markets and timber markets (the Subregional Timber Supply [SRTS] model) projects large reductions in the area of natural forest types (upland hardwood, bottomland hardwood, oak-pine, and pine) and large and mostly compensating increases in the area of pine plantation forests in the South over the coming decades.

Timber prices and the aggregate mixes of forest types depend only slightly on the rate of increase in pine plantation productivity change; the rate of timber demand growth has a proportionately larger effect on these measures.

The SRTS model projects rising timber prices and an increasing share of wood coming from plantation pine forests in the South in the coming decades.

Timber sale preparation costs reduce the profits of potential buyers and result in lower potential profits by sale bidders; greater information gathering by individual landowners before the sale can lower these potential losses and could result in a higher bid.

Uneven-aged management of southern pine is the most profitable use of forestland for a small share of owners of existing uneven-aged stands. This profitability depends on site productivity and initial state of the stand.

Disease research related to timber productivity has improved the returns to timber growing and thus increased forestland area in the South.

### Implications

Technological changes that increase timber productivity are key determinants of future forest productivity and the amount of natural and pine plantation forests.

The development of new technologies and the creation of new products that compete with current forest products could change the sensitivity of timber demand to price. Such changes would in turn alter land use patterns and the area of different forest types.

### New questions

Can models of plantation investment be refined to permit forecasting at finer spatial scales?

What are the effects of ownership, percelization, and forest fragmentation on investment and harvesting behavior, the timber market, aggregate land use patterns, and the level and character of non-timber values obtained from the land?

Is timber demand sensitivity changing over time, and what are the possible causes?

What rate of change in pine plantation technology can we expect across the South?

## Key citations

1. Abt, R. C., F. W. Cubbage, and G. Pacheco. 2000. Southern forest resource assessment using the Subregional Timber Supply (SRTS) model. Forest Products Journal 50(4):25-33.

2. Leffler, K. B., R. R. Rucker, and I. A. Munn. 2000. Transaction costs and the collection of information: presale measurement on private timber sales. Journal of Law, Economics and Organization 16(1):164-186.

3. Raunikar, R., J. Buongiorno, J. P. Prestemon, and K. L. Abt. 2000. Financial performance of mixed-age naturally regenerated loblolly-hardwood stands in the South Central United States. Forest Policy and Economics 1(3/4):331-346.

4. Wagner, J. E. and T. P. Holmes. 1999. Estimating economic gains for landowners due to time-dependent changes in biotechnology. Forest Science 45(2):163-170

5. Yin, R. 2001. Combining forest-level analysis with options valuation approach--a new framework for assessing forestry investment. Forest Science 47(4):475-483.

6. Yin, R. and D. H. Newman. 1999. A timber producer's entry, exit, mothballing, and reactivation decisions under market risk. Journal of Forest Economics 5(2):305-320.

## Related activities

Timber market modeling research provided the basis for forecasting timber market activities for the Southern Forest Resource Assessment.

The Southern Forest Assessment Consortium was rechartered and has been used to leverage additional funding for timber supply research in the South.

# Problem Area 2 - Spatial Assessment of Change in Southern Forests

## Definition

Increasing timber harvests coupled with other changes in how humans use forests have compounding effects on the characteristics of southern forests. The human population of the South has recently grown at rates faster than the national average. While this growth has long been focused in urban and coastal areas of the South, it has now spread more pervasively into rural areas. Resulting changes in landowner characteristics and demands for competing uses of land promise to transform the southern landscape. Research is needed to assess the effects of changing demographics, land ownership, land use, and other social forces on the extent, use, and structure of forests. Evaluating characteristics of forest structure such as fragmentation and diversity will require spatially explicit analyses at relatively fine scales. Linking human use patterns to changes in forest conditions will help define the long run implications of growth and development on ecological and environmental conditions such as biodiversity and water quality as well as market conditions such as timber availability and supply from private land. This information will provide crucial input for market analysis, conservation planning, and policy making at local, state, and regional levels. <u>Develop methods to assess the impacts of social forces on the extent, use, and structure of forests in the South</u>.

## Study Areas:

1. Develop models for estimating the effects of population growth, demographic change, and land markets on the allocation of land to various uses. Apply these models to forecast how and where land use is likely to change in the future, and link these changes to effects on timber markets.

2. Link models of land use and forest management to assess the impacts of these forces on the structure characteristics of forest landscapes including fragmentation and land cover diversity.

3. Develop methods to assess the impacts of production risk on forest conditions, management options, and choices in the South.

    a) Biotic risk factors

    b) Abiotic risk factors

## Accomplishments

Descriptions of research accomplishments are organized by the study areas listed above.

## Modeling and forecasting land uses

### Key findings

Research reexamined the common practice of modeling either urban or rural land use individually and treating the other as a residual. By incorporating both urban and rural land uses into a common model, we found that previously adopted approaches bias estimates of key parameters.

Land use elasticities with respect to population and other variables have been developed. Maps of these elasticities identify which Southern counties are most sensitive to possible population growth.

### Implications

This research provides an analytical framework for forecasting land use response to changes in population, income, and agricultural- and timber-based land rents.

Areas have been defined that are the most sensitive to future changes in the variables listed above. This provides a measure of development risk that is based on existing conditions rather than on forecasts of driving (exogenous) variables.

### New questions

Land use models generally treat population as a key driving (exogenous) variable. However, population growth and land use can be viewed as simultaneously determined. How can demographic projections and land use change be modeled jointly?

Land use models take institutional or policy factors such as taxation and zoning as a given. How can the mechanisms and effects of various policy instruments be incorporated into land use models? What are the effects of these policies in targeted and other areas?

### Key citations

1. Hardie, I., P. Parks, P. Gottleib, and D. Wear. 2000. Responsiveness of rural and urban land uses to land rent determinants in the U.S. South. Land Economics 76(4):659-673.

2. Parks, P. J., I. W. Hardie, C. A. Tedder, and D. N. Wear. 2000. Using resource economics to anticipate forest land use change in the U.S. Mid-Atlantic region. Environmental Monitoring and Assessment 63:175-185.

3. Wear, D.N. 2002. Land Use. Chapter 6. In (Wear and Greis, eds.) The Southern Forest Resource Assessment.

### Related activities

County level forecasts of land use have been used productively in RPA and SFRA.

We have completed a special project for EPA which modeled and forecasted land use changes in the mid-Atlantic region.  The findings were used by EPA analysts to drive fine scale simulation models within rapidly developing subregions.

## Land use and management effects on ecosystems

### Key findings

Changes in landscape pattern are "predictable" at various scales.

Topographic and locational features organize development of landscapes at very fine scales, these relationships have been defined.

Through research within the Coweeta LTER we have forecast land uses and constructed development hazard rates for watersheds in the Southern Appalachians.

### Implications

Consideration of ecological response to land use change may focus conservation concerns on a different portion of the landscape than if land use change were used alone.

### New questions

How can effective forecasts of ecological outcomes be constructed?

How can the effects of management and development on forest structure be predicted?

### Key citations

1. Wear, D. N., M.G.Turner, and R.J.Naiman. 1998. Land cover along an urban-rural gradient: implications for water quality. Ecological Applications 8:619-630.

2. Munn, I. A. and D. Cleaves. 1999. An analysis of losses to the southern commercial timberland base. Pages 198-202. In: Abt, K. L. and Abt, R. C. (ed.). Proceedings of the 1998 Southern Forest Economics Workshop. Research Triangle Park, NC: Southern Research Station.

3. Wear, D. N. 1999. Challenges to interdisciplinary discourse. Ecosystems 2:299-301.

4. Wear, D. N. and P. Bolstad. 1998. Land-use changes in Southern Appalachian landscapes: spatial analysis and forecast evaluation. Ecosystems 1:575-594.

5. Clark, J. S., S. R. Carpenter, M. Barber, S. Collins, A. Dobson, J. A. Foley, D. M. Lodge, M. Pascual, R. Pielke, Jr., W. Pizer, C. Pringle, W. V. Reid, K. A. Rose, O. Sala, W. H. Schlesinger, D. H. Wall, and D. Wear. 2001. Ecological forecasts: an emerging imperative. Science 293(5530):657-660.

6. Turner, M.G.; Pearson, S.M.; Bolstad, P. and Wear, D.N. 2003. Effects of land-cover change on spatial pattern of forest communities in the Southern Appalachian Mountains (USA). *Landscape Ecology* 18(5):449-464.

### *Related activities*

Modeling of land use conducted by the unit is the centerpiece of the Coweeta LTER's current six year funding cycle. This research attempts to tie spatial patterns of land and resource use to ecological impacts. Forecasts have been used to organize sampling schemes for aquatic and terrestrial ecologists in the project.

Invited author for Ecosystem's special issue on interdisciplinary research issues (1999).

The paper by Wear and Bolstad (1998) was selected as 2000 **Outstanding Paper in the Discipline of Landscape Ecology**, given by the International Association for Landscape Ecology (IALE), U.S. Regional Chapter.

Participation in NSF-funded workshop on ecological forecasting (2001) led to a paper describing the needs for integrated modeling to support forecasts of changes in ecological conditions.

Ongoing work funded by RPA is developing models to forecast forest fragmentation/structure in the United States (paper in process at Conservation Ecology).

## Assess biotic risk factors

### *Key findings*

Planting rust-resistant seedlings could save millions to tens of millions of dollars per year depending on how well rust-resistant pine seedlings are targeted to plantation locations at risk.

Benefit-cost ratios for past research identifying improved genetic resistance to fusiform rust in loblolly and slash pine were estimated to be between 4:1 and 6:1 through the year 2020.

Outbreaks of southern pine beetle in North Carolina, South Carolina, and Georgia show marked spatial and temporal correlation.

The probability of southern pine beetle outbreaks increases with a number of climatic variables including the amount of fall precipitation, the lack of summer precipitation, and increases in summer or winter daily maximum temperature.

The probability of southern pine beetle outbreaks increases with a number of variables related to forest structure such as the volume of sawtimber-size pines and national forest acreage (which typically contain pines in older age classes).

### *Implications*

Understanding of temporal and spatial components of abiotic risks to forests are essential complements to understanding of structural factors, for minimizing timber damages and economic losses in the South.

### *New questions*

How can we develop integrated assessments of multiple forms of production risk, for example ones that reflect a combination of biotic and abiotic factors?

How should forest managers and policy-makers allocate scarce resources to protect forests at risk from multiple damaging agents?

How will the constellation of nonnative pests affect the flow of benefits from the Southern Appalachian ecosystem?

Can effective mitigation or adaptation strategies be designed for the Southern Appalachian Mountains?

### *Key citations*

1. Cubbage, F. W., J. M. Pye, T. P. Holmes, and J. E. Wagner. 2000. An economic evaluation of fusiform rust protection research. Southern Journal of Applied Forestry 24(2):77-85.

2. Gumpertz, M. L., C.-T. Wu, and J. M. Pye. 2000. Logistic regression for southern pine beetle outbreaks with spatial and temporal autocorrelation. Forest Science 46(1):95-107.

3. Wu, C.-T. 1998. Generalized estimating equations for spatially correlated data. Ph.D. Department of Statistics, North Carolina State University. 197 pages.

4. Wu, C.-T., M. L. Gumpertz, and D. D. Boos. 2001. Comparison of GEE, MINQUE, ML, and REML estimating equations for normally distributed data. The American Statistician 55(2):125-130.

### Related activities

Research is currently underway to evaluate the total economic impact of the hemlock woolly adelgid on forest ecosystems in the eastern U.S., including loss of ecosystem services and impacts to residential landscapes, recreation, and timber supply.

## Assess abiotic risk factors

### Key findings

Wildfire patterns are organized on different portions of the landscape depending on current year climatic conditions; weather and or climate measures explain most of the interannual variation in observed wildfire in much of the U.S. South and West.

Road networks, stand and neighboring forest types, and site-specific wildfire history and understory vegetation appear to be related to wildfire risk at specific points in the landscape during a catastrophic wildfire year.

County-level wildfire risk in Florida is not statistically related to broad measures of the wildland urban interface and vegetation management, while timber harvesting without post-harvest site prep fuel reduction is a positive wildfire risk factor.

Historical fire patterns influence the probability of current year fire in quantifiable terms across broad scales; wildfire shows a suppressive effect that lasts between four and twelve years.

Efforts to mitigate wildfire risk through prescribed fire and other fuel management efforts have small or negligible effects on wildfire area but appear to exert larger effects on fire severity.

Weather factors may be related to the frequency and size of fires observed on a landscape; the size-frequency distribution of wildfire may then be used to assess aggregate annual risks of larger, more damaging wildfires.

Wildland arson is a statistically explainable and partially predictable process at the county spatial scale, with much of its intertemporal variation explained by current and predictable sea surface temperatures, recent arson ignitions in the same county, historical wildfire area in the same county, and factors measuring poverty and law enforcement expenditures.

Wildfire risk in the Western U.S. is predictable several months in advance of the wildfire season using indices of drought recorded in the months and years before the current wildfire season. The degree of predictability varies across the region.

### Implications

Wildfire season severity and wildfire suppression costs may be predictable using statistical models of wildfire risk based on historical wildfire and measures of drought for recent months and years within a region. Such predictability can help in the prepositioning of wildfire suppression resources and related vegetation management planning.

Wildfires might best be modeled by ignition sources, since ignition source-specific models differ and because ignition source frequencies vary across space.

Law enforcement can make a difference in reducing arson ignition risks but perhaps not the area of arson-ignited wildfires.

Initial findings are that wildfire responds to vegetation management, and suppression resources applied.

### New questions

Can the relationships among alternative measures to reduce damages and save values at risk to wildfire be estimated and used in an overall picture of how to optimally intervene in wildfire regimes?

Can wildfire risk and ignition risk predictability at various spatial and temporal scales be used to facilitate prepositioning of suppression and law enforcement resources and timing of vegetation management?

How do responsivenesses of wildfire regimes to interventions vary over time, across space, and across ecological and socioeconomic gradients?

What is the best statistical expression of wildfire production at each spatial and temporal scale to address questions about the effects of interventions?

### Key citations

1.  Butry, D.T., D.E. Mercer, J.P. Prestemon, J.M. Pye, and T.P. Holmes. 2001. What is the price of catastrophic wildfire? Journal of Forestry 99(11):9-17.

2.  Butry, D.T., J.M. Pye, and J.P. Prestemon. 2002. Prescribed fire in the interface: separating the people from the trees. P. 132-136 in Outcalt, K.W. (ed.) 2002. Proceedings of the eleventh biennial southern silvicultural research conference. Gen. Tech. Rep. SRS–48. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 622 p.

3.  Prestemon, J.P., J.M. Pye, D.T. Butry, T.P. Holmes, and D.E. Mercer. 2002. Understanding broad scale wildfire risks in a human-dominated landscape. Forest Science 48(4):685-693.

4.  Holmes, T.P, J.P. Prestemon, J.M. Pye, D.T. Butry, D. Evan Mercer, and Karen Abt. 2003. Using size-frequency distributions to analyze fire regimes in Florida. *In* W.J. de Groot and R.T. Engstrom (eds.), Fire in temperate, boreal and montane ecosystems, Proceedings of the Tall Timbers 22nd Fire Ecology Conference. Tall Timbers Research Station and the Canadian Forest Service, October 15-18, 2001, Kananaskis Village, Alberta, Canada.

5.  Pye, J.M., J.P. Prestemon, D.T. Butry, and K.L. Abt. 2003. Prescribed burning and wildfire risk in the 1998 fire season in Florida. *In* Omi, P. (ed.), Conference on Fire, Fuel Treatments and Ecological Restoration, April 16-18, 2002, Ft. Collins, CO.

6.  Westerling, A.L., A. Gershunov, D.R. Cayan, et al. 2002. Long lead statistical forecasts of area burned in western US wildfires by ecosystem province. International Journal of Wildland Fire 11(3-4):257-266.

***Related activities***

The unit is managing two ongoing studies funded by the National Fire Plan, evaluating how wildfire affects and communities respond to large wildfires (The Impact of Wildfire on Local Economies) and the efficacy of alternative vegetation management techniques to reduce the damages from wildfire (The Trade-Offs of Alternative Vegetation Management Techniques).

The unit has completed one study funded in 1999 by the Joint Fire Sciences Program, "The Ecological and Economic Impacts of the Florida 1998 Wildfires" A second JFSP grant funded in 2002 is titled "A National Study of the Economic Impacts of Biomass Removals to Mitigate Wildfire Damages on Federal, State, and Private Lands" which seeks to quantify how the federal government's 10-year strategy to mitigate wildfire damages could affect local and regional forest product markets and affect producers and consumers.

A wildfire research workshop titled "Fire Science and Fire Management in Southern Forests" was co-organized by the Unit with SRS-4104, Disturbance and the Management of Southern Pine Ecosystems and held in Sarasota, Florida, in November, 2002. The conference was organized to showcase fire-related research in the South for fire managers and decision makers. It was attended by over 80 scientists and land managers from representatives of local, state, and federal government and by representatives from several private organizations.

# Problem Area 3 - Measures of Sustainability

## Definition

Sustainability provides a unifying framework for evaluating the overall effects of human uses of land and resources. It has emerged as the conceptual framework for international comparisons of forest use and condition and of assessments at various scales. Issues that need to be resolved include utility tradeoffs between current and future generations, the distributional implications of forest use, and meaningful measures of forest value. This information is needed by policy analysts at regional to international levels to design, interpret, and compare various "indicators" of the sustainability of forests and their uses. Develop methods for measuring the sustainability of forest ecosystems.

Increasing public concern regarding the condition of natural systems throughout the world has focused attention on the monitoring of forest ecosystems and their ability to provide goods and services in a sustainable fashion. Monitoring requires development of indices or indicators that summarize change in meaningful ways. Meaningful measures of sustainable forestry will be developed through the following studies.

## Study Areas

1. Improve the definition of needs for monitoring sustainability through an exhaustive literature review. Use this review to refine objectives for subsequent studies.

2. Improve methods for measuring the total value of *in situ* forests as well as extracted forest products and incorporating these values in regional and national economic accounting.

3. Develop methods for assigning value to physical measures of forest inventory. Apply these methods to better understand changes in the ability of forests to provide utility.

4. Contribute new approaches to assessing the sustainability of forests in the South.

(Note: The second and third study areas are combined in the discussion below.)

## Accomplishments

Descriptions of research accomplishments are organized by the study areas listed above

## Understanding sustainability

### Key findings

The definitions of sustainability have varied over time and depend on the goals of the definer.

Additional monitoring needs are identified in the Southern Forest Resource Assessment (see PA 3.4). Although these were specifically developed for southern forests, they are broadly applicable to all U.S. forests.

### Implications

Considerable science still needs to be done before the data will be available to measure sustainability. In addition, the questions of what needs to be measured have not been fully explored, and this is likely to occur at the international or national level. Defining, measuring and monitoring sustainability provide a cycle of activities-- a classic chicken-or-egg dilemma. With respect to sustainability the definition is so broad and complex, that it provides little help in directly determining what to measure. At this time, sustainability has more to do with an ongoing public discourse regarding measures of value than it does with defining a precise scientific description of meaningful change in interlinked biological-social-physical systems .

### New questions

The big questions in this area are philosophical and stem from our needs as a society to control the future. Although the ideal of a return to the form of sustainability present at the time of anglo settlement is appealing, it is most likely unachievable. What, then, is achievable? Can we move from pre-settlement sustainability to a practical sustainability?

### Key citations

1. Moffat, S. O., F. W. Cubbage, T. P. Holmes, and E. O'Sullivan. 2001. Characterizing the sustainable forestry issue network in the United States. Forest Policy and Economics 2(3-4):307-318.

2. Wear, D. N., R. Abt, and R. Mangold. 1998. People, space, time: factors that will govern forest sustainability. P.348-361. Transactions of the 63rd North American Wildlife and Natural Resources Conference. Washington, D.C.: Wildlife Management Institute.

3. Moffat, S.O. and K.L. Abt. Unpublished manuscript. Forest sustainability: a literature review.

4. Wear, D. N. 2000. Forest land use changes: fragmentation, urbanization and population. Proceedings: Perspectives on Sustainable Forestry for the South. Raleigh, NC: The Southern Center for Sustainable Forests, North Carolina State University.

## Sustainability of forest production and local communities

### Key findings

Extractive timber production continues to be important in the regional economy of the South, but less important in the Mid-Atlantic. Employment is declining in both regions, and the future is uncertain. Non extractive uses of forests contribute to both quality of life and economic well being.

Recreation in and on forests is also important in regional and national economies. It's importance is increasing, but not increasing faster in the South than the rest of the country.

### Implications

Timber production on public lands is still an important issue, but attention is increasingly focused on non-public land management decisions.

Distribution of forest benefits can be summarized as: participants with higher incomes favor and receive more non-market benefits, while those with lower incomes favor and receive more market benefits.

### New questions

Linkages between forests and human communities are changing as both supplies and demand change. How do these linkages affect local economies?

What are the relationships between forests, forestry and the macro-economy?

Can we develop better measures of the forest recreation based drivers of local economies?

### Key citations

1. Abt, K. L., J. L. Greene, and R. C. Abt. 1999. Chapter 6 - Timber Resources [in Ozark-Ouachita Highlands Assessment Report 4 - Social and Economic Conditions]. General Technical Report SRS-34. Asheville, NC: USDA Forest Service, Southern Research Station. P.167-209.

2. Aldy, J. E., R. A. Kramer, and T. P. Holmes. 1999. Environmental equity and the conservation of unique ecosystems: an analysis of the distribution of benefits for protecting Southern Appalachian spruce-fir forests. Society and Natural Resources 12:93-106.

3. Aruna, P. B. and D. E. Mercer. 1999. The timber economy of the Mid-Atlantic Region: some preliminary results from the Mid-Atlantic Integrated Assessment. Pages 172-179. In: Abt, K. L. and Abt, R. C. (ed.). Proceedings of the 1998 Southern Forest Economics Workshop. Raleigh, NC: North Carolina State University.

4. Busby, R. L., K. L. Abt, and C. Redmond. 1999. Chapter 4 - Economic Profile [in Ozark-Ouachita Highlands Assessment Report 4 - Social and Economic Conditions]. General Technical Report SRS-34. Asheville, NC. USDA Forest Service, Southern Research Station. P.99-130.

5. Raunikar, R. and J. Buongiorno. 1999. [The role of economics in forest management: from Faustmann to the environmental Kuznets curve]. Revue Forestiere Francaise Numéro Spécial:102-116.

6. Raunikar, R. and J. Buongiorno. 2001. Valuation of forest amenities: a macro approach. P.118-123. In: Pelkki, M. H. (ed.). Proceedings of the 2000 Southern Forest Economics Workshop. Monticello, Arkansas: School of Forest Resources, University of Arkansas.

7. Abt, K.L., S.A. Winter, and R.J. Huggett, Jr. 2002. Local Economic Impacts of Forests. In: Wear, D.W. and J.G. Greis (eds.), Southern Forest Resource Assessment, General Technical Report SRS-53, USDA Forest Service, Southern Research Station, Asheville, NC. Pp. 239-268.

8. Holmes, T.P. 2003. Forests and the Quality of Life. Chapter 12 in (Wear and Greis, eds.) The Southern Forest Resource Assessment: Technical Report. USDA Forest Service, General Technical Report SRS-53, pp. 283-298.

### Related activities

Participation in regional assessments (SOFRA, OOHA, MAIA)

Contribution to development of Criteria and Indicators for 2003 report.

Contribution to RPA Assessment activities.

## Assessing forest sustainability in the South

### Key findings

Increasing population, combined with the resulting conversion of forests to non-forest uses will continue to affect the extent, condition, and health of forests.

Timber production is forecast to expand but not deplete forest inventories below present levels.

Investment in pine plantations is forecast to continue to expand to meet increased softwood demand, resulting in some changes to the ecological characteristics of southern forests.

Changes in forest uses will affect both the quality of life and economic well-being of communities in the south.

Southern forests have proven resilient, but some components are scarce and therefore vulnerable to change. These scarce forest types have high ecological value

### Implications

Monitoring—The crux of sustainability is to understand change and respond to it. It is, therefore, imperative to have timely data with which to gauge changes in forest conditions.

Delivery of forestry assistance—The changing demographics of forest landowners suggest changing preferences and management objectives for private forests. It seems clear that nonindustrial private forest landowners, especially in the urbanizing eastern portion of the region, will need a broad range of silvicultural options and assistance now and in the future.

Public land—Demands for forest-based recreation opportunities are expanding rapidly. Private land is becoming less accessible for these kinds of activities, so public land is coming under increasing pressure to supply a broad variety of recreation opportunities. In some parts of the South, public land provides islands of interior forest habitat. These habitats have very high and increasing ecological value as refuges for rare species.

### New questions

Expanding populations and impacts on ecosystems—More heavily populated rural and urban landscapes will impact wildlife, water, and other benefits derived from forested ecosystems in the South. Additional information is needed to reduce uncertainties regarding: (1) forecasts of how and where these changes might occur, (2) how human population density influences forest ecosystems and options for their management, and (3) how development can be designed to promote forest sustainability.

Markets, management, and values—Because private landowners control most southern forests, forest conditions are determined by private management choices. A full accounting and understanding of how values are formed and how decisions are made is crucial for clarifying how forest uses and the flow of benefits will change in the future.

Forest productivity—The productivity of forest ecosystems is a key factor in determining land allocation, forest use, and ultimately forest conditions across the South. Productivity extends beyond timber production to include the provision of wildlife, clean water, and other benefits of forests, and is influenced to uncertain degrees by several forces of change.

Forecasting ecological changes—Tools are not available for: (1) forecasting the implications of multiple, interacting changes on the area, structure, and function of southern forest ecosystems, and (2) fully understanding the impacts on values that are derived from these systems. Such tools would help identify emerging scarcities within the region.

Analysis at landscape and regional scales—Science and management conducted at these broad scales are relatively new endeavors. Most forest research has been conducted at very fine scales, often without the information needed to develop implications at broader scales.

Fire ecology and management—Elimination of natural fire cycles is one of the most substantial alterations imposed by humans on the forested ecosystems of the South. Uncertainties exist regarding: (1) the role of fire in specific ecotypes, and (2) strategies for effectively and safely reintroducing fire into forest ecosystems.

Pine plantations and ecosystem functions—Some portions of the South will see increased concentrations of pine plantations. Landscape-level ecological implications of increased pine plantations are uncertain.

Forest management approaches—There is an increasingly complex environment for conducting forest management and suggests a need for a broader array of management strategies. New management approaches are especially needed for managing forests in wildland-urban interface areas.

### Key citations

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2. Greis, J.G. and D.N. Wear. 2002. Conducting Science in the Public Eye. Journal of Forestry. 100(7):46-49.

3. Wear, D.N., and J.G. Greis (editors). 2002. The Southern Forest Resource Assessment: Technical Report. USDA Forest Service, General Technical Report SRS-53, 635 pp.

4. Wear, D.N., and J.G. Greis. 2002. The Southern Forest Resource Assessment: Summary Report. USDA Forest Service, General Technical Report SRS-54, 103 pp.

5. Wear, D.N. 2002. Land Use. Chapter 6 in (Wear and Greis, eds.) The Southern Forest Resource Assessment: Technical Report. USDA Forest Service, General Technical Report SRS-53, pp. 153-187.

6. Holmes, T.P. 2003. Forests and the Quality of Life. Chapter 12 in (Wear and Greis, eds.) The Southern Forest Resource Assessment: Technical Report. USDA Forest Service, General Technical Report SRS-53, pp. 283-298.

7. Abt, K.L., S.A. Winter, and R.J. Huggett, Jr. 2002. Local Economic Impacts of Forests. In: Wear, D.W. and J.G. Greis (eds.), Southern Forest Resource Assessment, General Technical Report SRS-53, USDA Forest Service, Southern Research Station, Asheville, NC. Pp. 239-268.

8. Prestemon, J.P., and R.C. Abt. 2003. Timber Products Supply and Demand. Chapter 13 in (Wear and Greis, eds.) The Southern Forest Resource Assessment: Technical Report. USDA Forest Service, General Technical Report SRS-53, pp. 299-326.

9. Wear, D.N. 2003. Large Scale Regional Assessments: Lessons learned from the Southern Appalachian Assessment. In V. Dale (ed.), Ecological Modeling for Resource Management. Springer-Verlag, New York.

### Related activities

RWU-4851 contributed substantially to the Southern Forest Resource Assessment, including leadership (Dave Wear), scientist contribution to the chapters (Dave Wear, Tom Holmes, Karen Abt, Jeff Prestemon), administrative assistance (Renee Boozer), and web site development, maintenance and publication (John Pye).

# Problem Area 4 - Understanding values of forest goods and services on different land ownerships

## Definition

Public values will continue to shape the debates regarding existing and potential rules and regulations regarding the protection and management of forest land. A better understanding of how these values are formed and evolve, what values are promoted by special interest groups, and how representative interest groups are of the larger public will help forestland managers and policy makers formulated and implement policies in keeping with what the public wants. The following studies will be conducted to improve understanding in this area:

## Study Areas

1. Improve understanding of how forests ecosystem conditions influence the values held by the general public and by various public subgroups.

2. Develop methods for aggregating across ecosystem conditions and across members of society to define total value.

3. Improve nonmarket valuation methods for estimating total ecosystem values and for understanding how educations and other factors affect these values.

4. Link public and private nontimber values to forest management decisions and timber supply implications.

## Accomplishments

Descriptions of research accomplishments are organized by the study areas listed above

## Linking forest ecosystem conditions and public values

### Key findings

People living in North Carolina strongly prefer the production of ecological services and non-consumptive benefits over either priced or non-market consumptive benefits produced by National Forests in the Southern Appalachian Mountains.

Forest values held by a random sample of the public were more similar to values held by a sample drawn from environmental organizations than values held by samples of hunters, anglers and those employed in the wood products industry.

Throughout the South, population growth in forested areas is greater where forest-based recreation is relatively more important as a forest use. Conversely, population growth is slower in forested areas dominated by intensively managed forests.

Ecosystem attributes can be described as non-separable bundles of latent characteristics. These ecosystem bundles have relevance to the decisions that people make regarding recreational choices and can be used to estimate the value of forest-based recreation under alternative forest conditions.

### Implications

Public surveys regarding forest management activities, plans and regulations can provide balanced information to decision makers regarding the impact of changes in forest ecosystem conditions on human welfare.

The intensification of forest management on private forests in the South impacts the character of the forest landscape and the production of publicly available forest amenities such as clean water, wildlife habitat and aesthetically pleasing views. Changes in the supply of forest amenities affect the habitability of landscapes and decisions of where to live which, in turn, influence property values.

Research on the linkages between ecosystem attributes and human welfare needs to be cognizant of the non-separability problem and the latent characteristics model may be particularly important for developing economic-ecologic models.

### New questions

How do forest cover, forest type and forest management systems affect human welfare in the South?

To what degree do public forests produce positive environmental externalities on surrounding private land?

Do specific forest management activities on private forests produce negative environmental externalities?

How heterogeneous are preferences for forest landscapes and management regimes in the South, and is preference heterogeneity related to geographical variables/ place of residence?

How can information on public preferences for alternative forest management activities be applied in local or regional planning efforts?

How can information obtained from random samples of the public and interest groups be optimally combined to improve decision-making regarding forest management and protection?

### Key citations

1. Holmes, T.P. 2002. Forests and the quality of life. Pages 283-295. In: Wear, D. and J. Greis (ed.). Southern Forest Resource Assessment, General Technical Report, Southern Research Station, Asheville, NC.

2. Schaberg, R.H., T.P. Holmes, K.J. Lee, and R.C. Abt. 1999. Ascribing value to ecological process: an economic view of environmental change. Forest Ecology and Management 114: 329-338.

3. Pendleton, L.H. and J.S. Shonkwiler. 2001. Valuing bundled attributes: a latent characteristics approach. Land Economics 77(1): 118-129.

### Related activities

Participated in the Marketing Resources Group effort to evaluate the recreational user fee program as a model for incorporating marketing concepts in public decision making.

Established a joint collaboration with Coweeta Hydrologic Lab to evaluate the costs and benefits of riparian ecosystem restoration.

## Values across ecosystem conditions and members of society

### Key findings

Components of silvicultural systems can be meaningfully described to the general public and such components can be meaningfully valued in economic terms using survey techniques. The total value of alternative silvicultural systems can then be estimated as the sum of component values.

The total value of restoring an entire riparian ecosystem is greater than the sum of restoration programs valued independently.

### Implications

Alternative silvicultural practices implemented on private land may have economic impacts on the general public.

Determining the correct scale for ecosystem valuation is important.

### New questions

What forest qualities influence the values that people hold?

How do alternative silvicultural practices implemented on private land impact the value of the public goods produced?

Does the spatial configuration of silvicultural activities (e.g., intensive versus extensive) influence social welfare?

What is the proper scale for conducting ecosystem valuation studies?

### Key citations

1. Holmes, T.P. and W. Adamowicz. 2003. Attribute based methods. Pages 000-000. In: Boyle, K.J., T. Brown, and P. Champ (ed.). A Primer on Non-Market Valuation. Kluwer Academic Publishers. Dordrecht, The Netherlands.

2. Boyle, K.J., T.P. Holmes, M. Teisl, and B. Row. 2002. An analysis of conjoint analysis response formats. American Journal of Agricultural Economics 84(4): 441-454.

3. Holmes, T.P., K.J. Boyle, M. Teisl, and B. Row. 2003. An analysis of conjoint analysis response formats: reply. American Journal of Agricultural Economics.

4. Holmes, T.P. and K.J. Boyle. 2003. Stated preference methods for valuing forest attributes. In: Sills, E.O. and KL. Abt (eds.). Forests in a Market Economy. Kluwer Academic Publishers. Dordrecht, The Netherlands.

5. Holmes, T.P., J. Bergstrom, E. Huszar, S. Kask, and F. Orr.  2002. Estimating the local economic benefits of riparian ecosystem restoration using iterated contingent valuation.  Working Paper FS 02-08, University of Georgia, Athens.

*Related activities*

Provided help in developing a strategic plan for the Environmental Protection Agency's National Center for Environmental Economics.

Evaluated the economics of Off-Highway Vehicle use on National Forests in Western North Carolina in collaboration with scientists in the Recreation RWU in Athens, Georgia.

## Total ecosystem values value formation

### Key findings

Contingent valuation is a useful tool for estimating, understanding and predicting the total (holistic) value of forest ecosystems. Contingent values vary by socio-economic and demographic factors.

On-site information about historical and current silvicultural activities, and the impact of silvicultural activities on ecosystem structure, composition and function, does not influence public preferences for alternative silvicultural systems.

Willingness to pay values estimated from a random sample of people provided on-site information was different than WTP estimated from a random sample of mail respondents.

### Implications

Contingent forest values vary in predictable ways, implying that there may be unobserved spatial patterns to forest values. These, in turn, provide input for local land use planning decisions.

Public preferences for alternative forest management systems are formed over long periods of time and are not influenced in predictable ways by short-term, specific information.

Although small, on-site samples allow information to be collected at lower cost, willingness to pay results may be biased by a non-representative sample population with more strongly held opinions than the general public.

### New questions

Do forest ecosystem values vary across sub-regions of the South? If so, how would regional variation influence efforts at local and regional land-use planning?

How does new information affect public preferences for forest management and protection?

How can the public be best educated about issues relating to forest management?

Are public preferences consistent with scientific findings regarding the sustainable management of forests?

### Key citations

1. Kramer, R.A. and T.P. Holmes. 2003. Using contingent valuation to estimate the value of forest ecosystem protection. In: Sills, E.O. and KL. Abt (eds.). Forests in a Market Economy. Kluwer Academic Publishers. Dordrecht, The Netherlands.

2. Pullis, G. 1998. Public perceptions of forest ecosystem attributes and economic values for small, private woodlots with and without alternative timber harvesting. MS Thesis, University of Maine. 138 pages.

3. Sargent-Michaud, J., K. J. Boyle and T. P. Holmes. 2003. Valuing complex environmental resources with mail and on-site surveys. Working Paper, University of Maine, Orono.

### *Related activities*

Research is currently ongoing in support of Region 8 State and Private Forestry efforts to evaluate the economic impact (market and non-market) of hemlock wooly adelgid in the eastern U.S..

Continuing participation in the Southern Appalachian Cross-Cutting Theme of the Southern Research Station regarding community development and economic sustainability in mountain ecosystems.

## Influence of nontimber values on management and timber supply

### *Key findings*

Measures of forest structure that have been related to nontimber values in other research significantly affect southern pine timber harvesting behavior on both nonindustrial and industrial forests in North Carolina.

### *Implications*

An increase in the value placed on non-timber outputs of forests may lead to an increase in the length of timber rotations and a decrease in timber supplied from non-industrial private forests.

Some industrial forest land may be sold where its conservation values exceed its timber value.

### *New questions*

What biophysical factors are associated with amenity values produced on NIPF land?

How are amenity producing factors spatially distributed across the South and over time and what are the implications for regional timber supply?

How do timber harvesting decisions made on individual parcels influence subsequent harvest decisions within a neighborhood of parcels?

### *Key citations*

1. Prestemon, J. P. and D. N. Wear. 2000. Linking harvest choices to timber supply. Forest Science 46(3):377-389.

2. Abt, K. L., and J. P. Prestemon. 2003. Optimal stand management: classical and neoclassical solutions. In, Sills, E. O. and K. L. Abt (eds.). Forests in a Market Economy. Kluwer Academic Publishers. Dordrect, The Netherlands.

3. Pattanayak, S., K. L. Abt, and T. P. Holmes. 2003. Timber and amenities on non-industrial private land. In, Sills E. O. and K. L. Abt (eds.). Forests in a Market Economy. Kluwer Academic Publishers. Dordrect, The Netherlands.

### *Related activities*

Participation with various institutions, including the U.S. Forest Service International Programs, USAID, the Tropical Timber Foundation and University of Florida, in developing methods for evaluating the economics of reduced impact logging in the tropics.

# Problem Area 5 - Forest Policy

## Definition

The effectiveness and impacts of forest policy, programs, and regulations have come under increasing scrutiny with the growing public concern over the sustainability of current forest practices. Insufficient information and analytical methods are available for assessing the efficiency and equity impacts of past and present forest policy, programs, regulations, and incentives and for predicting landowner responses to proposed policies and programs. These informational needs are paramount for the design of forest policy in the U.S., but equally important in tropical developing countries, Eastern Europe, and the former Soviet Union. Develop better methods for assessing the economic and resource implications of forest policies and programs in the United States. Apply these methods to historical and potential future policies to evaluate their effectiveness.

## Study Areas

1. Develop better methods for assessing the economic and resource implications of forest policies and programs in the United States. Apply these methods to historical and potential future policies to evaluate their effectiveness.

2. Improve methods for evaluating forest policies in various governmental and institutional settings, such as developing tropical countries where property rights may be indeterminable and eastern Europe where private markets for resources have emerged only recently.

3. Improve methods for determining the distribution of economic impacts of various forest policies across race, subregions, and income groups.

4. Develop better information on changing objectives of nonindustrial private forest landowners and their response to policies, regulations, and programs. Use these findings to evaluate the potential effectiveness of alternative policy designs.

## Accomplishments

Descriptions of research accomplishments are organized by the study areas listed above.

## U.S. forest policy and program analysis

### Key findings

"Ecosystem management" complicates forest management considerably. Explicit recognition of ecological interactions, even between identical forest stands, may prescribe specialization through time and across space. The implication is that harvest timing choices determined by single stand models—even with ecological values--may reduce the flow of value from the forest as a whole.

Position along the urban-rural gradient has a significant effect on land-cover changes on private lands but not on public lands and a compounding effect on land-cover changes through interactions with other variables such as slope. Simulations indicate that ecological consequences of development may be highest both at the periphery of cities and at some distance from this edge, where development is first initiated.

### Implications

Landscape simulation approaches can be used to identify where and how land use decisions may have critical influence over environmental quality, thereby focusing both future research and monitoring efforts and watershed protection measures

### New questions

How will the reduction in industry ownership and increase in TIMO ownership of southern forestlands impact state and federal forest policy?

How will growing urban sprawl in the South affect forest policy?

What policies, programs, and incentives will be most effective in preserving and restoring wetlands and bottomland hardwood forests?

Following large wildfires, hurricanes, and other large scale natural disasters, what policies and programs could mitigate timber market welfare losses?

### Key citations

1. Murray, B. C. and D. N. Wear. 1998. Federal timber restrictions and interregional arbitrage in U.S. lumber. Land Economics 74(1):76-91.

2. Carter, D. R. and D. H. Newman. 1998. The impact of reserve prices in sealed bid federal timber sale auctions. Forest Science 44(4):485-495.

3. Swallow, S. K., P.Talukdar, and D.N. Wear. 1998. Spatial and temporal specialization in forest ecosystem management under sole ownership. American Journal of Agricultural Economics 79:311-326.

4. Wear, D.N., and B.C. Murray. In press. Federal Timber Restrictions, Interregional Spillovers, and the Impact on U.S. Softwood Markets. Journal of Environmental Economics and Management.

5. Wear, D. N., M.G. Turner, and R.J. Naiman. 1998. Land cover along an urban-rural gradient: implications for water quality. Ecological Applications 8:619-630.

6. Wong, G., J.R.R. Alavalapati, and R.J. Moulton. Assessing the economic approaches to climate-forest policies: A critical survey. World Resources Review (In Press).

7. Wong, G. and J.R.R. Alavalapati. The land-use effects of a forest carbon policy in the U.S. Forest Policy and Economics (In Press).

## *Related activities*

A chapter is being written on the proper role of government in forest restoration a book on restoration of boreal and temporal forests to be published by CRC Press.

Invited to present a paper on the influence of program design attributes on wetland restoration policy effectiveness for the Association of State Wetlands Managers' Workshop on Stream, Floodplain, and Wetland Restoration, Nov. 2002.   Invited to participate in Association of State Wetland Managers' Annual Federal/State Wetland Programs Winter Meeting, Jan 2003

## Wildland fire policy and program analysis

### Key findings

The effect of traditional prescribed burning on wildfire risk is usually insignificant but varies by ignition source. Hence, broadly applied prescribed fire may not result in much reduction in wildfire area; more important factors are somewhat beyond the control of wildland managers, including drought conditions.

Wildfires of large sizes may not have been affected by vegetation management, even though prescribed fire might fit in the natural fire regime, because such burning compensates favorably for small and low intensity wildfires but not for large, high-intensity wildfires.

Wildfires have broad effects on local economies, ranging from timber markets, trade and tourism sectors, and resource expenditures in firefighting. In Florida, the most of the damages caused by the 1998 catastrophic wildfires were in the timber sector.

### Implications

Prescribed burning may be effective for reducing wildfire risk at the individual stand or ownership level, but effects of prescribed burning for reducing wildfire risk at the landscape level appear minimal in Florida.

The risks of catastrophic wildfires may not be significantly affected by vegetation management activities.  Although such activities might lower some timber damages, published research has not been able to evaluate the net economic benefits of such efforts broadly applied on government lands that are not managed for timber.

Modeling at finer spatial and temporal scales might further enhance our understanding of how land managers can best reduce the longer term risk of catastrophic wildfire damages.

Wildfires can have large effects on local communities. In regions with significant timber values on the ground, catastrophic wildfires can have very large costs; there, timber market effects of fires dominate the local economic impact, followed by suppression, effects on trade and tourism, and then on public health. In other regions, trade and tourism and wildfire suppression are the largest costs.

### New questions

What is the economically optimal amount, location, and distribution over time of vegetation management for reducing the impacts from wildfire?

Following large wildfires, hurricanes, and other large-scale natural disasters, what policies and programs could mitigate timber market welfare losses?

What policies and programs have been or could be successful at reducing the risks of timber damages and community damages from wildfire?

How do wildfires affect different segments of a local economy, what are the determinants of how each segment is affected, and how do those effects relate to national-scale transfers and wildfire suppression and rehabilitation expenditures?

### Key citations

1. Mercer, D. E., J. M. Pye, J. P. Prestemon, D. T. Butry, and T. P. Holmes. 2000. Economic effects of catastrophic wildfires. www.rtp.srs.fs.fed.us/econ/pubs/dem001.htm.

2. Prestemon, J. P., D. E. Mercer, J. M. Pye, D. T. Butry, T. P. Holmes, and K. L. Abt. 2001. Economically optimal wildfire intervention regimes. Paper presented at the American Agricultural Economics Association Annual Meeting. Chicago, IL: American Agricultural Economics Association.

3. Butry, D.T., D.E. Mercer, J.P. Prestemon, J.M. Pye, and T.P. Holmes. 2001. What is the price of catastrophic wildfire? Journal of Forestry 99(11):9-17.

4. Prestemon, J. P., J. M. Pye, D. T. Butry, T. P. Holmes, and D. E. Mercer. 2002. Understanding broadscale wildfire risks in a human-dominated landscape. Forest Science 48(4):685-693.

5. Holmes, T.P., J.P. Prestemon, J.M. Pye, D.T. Butry, D.E. Mercer, and K.L. Abt. Using size–frequency distributions to analyze fire regimes in Florida. Pages 000–000 in R.T. Engstrom and W. J. de Groot (eds.). Proceedings of the 22nd Tall Timbers Fire Ecology Conference: Fire in Temperate, Boreal, and Montane Ecosystems. Tall Timbers Research Station, Tallahassee, FL.

### Related activities

Organized a special session on fire economics and policy and delivered 4 papers for the Society of American Foresters 2002 Convention, Winston-Salem, NC Oct. 2002.

Organized a conference entitled Fire Science and Management in Southern Forests at which unit members delivered four papers.  Sarasota, FL.  Nov 2002.

Three members of the Unit assisted Dr. Fred Stewart, Region 1 Economist, in evaluating the price effects of salvaging fire-killed timber on the Bitterroot National Forest, Montana. Salvage rates are a policy choice of National Forest managers that may have significant implications for local communities, wood buyers, and private timberland owners. We quantified the price effects of alternative scales of government salvage, as considered in an Environmental Impact Statement developed by the National Forest.

Three members of the Unit were contacted on August 14, 2003, by Rich Fairbanks of the Forest Service's interdisciplinary team evaluating alternatives for, among other things, timber salvage rates for the Biscuit Fire. Mr. Fairbanks was asked to address two new alternatives based in part on a report by Sessions et al. (2003). This report recommended consideration of larger salvage efforts than evaluated with the initial set of alternatives developed by the team. Mr. Fairbanks asked, "What would be the price impacts of these large rates of salvage?" We conducted an abbreviated analysis of the salvage, including quantifying the price effects of alternative rates of salvage. The market

analysis was submitted on October 1, 2003. Work continues to create a journal-quality manuscript from this effort.

An ongoing cooperative study with North Carolina State University Department of Forestry is evaluating how communities in the western U.S. are responding to wildfire risks. From that research will come insights into the reasons why some communities prepare effectively for such risks and others do not.

Another ongoing cooperative study with North Carolina State University, in the Economics Department, is evaluating how house prices evolve over time following a catastrophic wildfire near or in the community. This research, which will form part of the dissertation of an Economics graduate student, should shed light on how communities respond to risk and how perceptions of risk change over time and with respect to whether the community has recent experience with a damaging wildfire. That research may lead to a greater understanding of the kinds of incentives and programs likely to be effective in motivating risk-mitigation strategies in communities found in fire prone landscapes.

Research in the unit on the effectiveness of resource inputs into wildfire suppression should shed light on the apparent growth in the costs of large wildfires in the U.S. This National Fire Plan funded study could be an integral component in the development of a new generation of a wildfire cost forecasting model for the Forest Service and other federal agencies.

Continuing research into wildfire vegetation management policies will evaluate how intense and unintense wildfire activity in Florida is related to vegetation management efforts. Western wildfire research evaluating the efficacy of such management is also ongoing.

Arson wildfires are linked statistically to vegetation management activities, law enforcement, and poverty measures. These findings, unique to the crime literature and wildfire literature and contained in a manuscript in process, have implications on the best way to reduce risks of these kinds of fire ignitions.

## International forest policy and program analysis

### Key findings

Reduced impact logging can be financially more profitable than conventional logging. This implies that economic self interest may help mitigate the loss of ecological services in tropical forests subject to logging pressure.

Agroforestry intensity, private ownership, land fragmentation, and familiarity with soil conservation are related positively to improved soil quality. Investments in agroforestry to improve or maintain soil capital can increase annual agricultural profits by about 6% of total income for the typical household

Although a common popular assertion is that trade liberalization encourages deforestation, Prestemon's analysis showed that NAFTA will have positive long-run effects on forest cover in Mexico but that this is net of losses on private lands

### Implications

Reduced impact logging is necessary but not sufficient for the development of sustainable timber management in tropical production forests. Understanding the conditions under which reduced impact logging is competitive with conventional harvest methods would help target investments in sustainable timber management.

Environmental Impacts of trade liberalization are not straight-forward. Increased research is needed to determine direction of impacts under different conditions.

### New questions

What is the role of governments in influencing local patterns of deforestation in remote, frontier forested areas and forest degradation by major state-supported activities such as the timber industry?

How do policies, property right systems, and social institutions influence land use in tropical frontier regions?

What are the major constraints to private investment in sustainable timber management in the tropics?

What options do governments in tropical countries have to promote sustainable timber management, and which options would be the most cost effective?

### Key citations

1. Boltz, F., D.R. Carter, and T.P. Holmes. 2001. Financial returns under uncertainty for conventional and reduced-impact logging in permanent production forests of the Brazilian Amazon. Ecological Economics 39(2001):387-398.

2. Holmes, T. P., G. M. Blate, J. C. Zweede, R. Pereira, Jr., P. Barreto, F. Boltz, and R. Bauch. 2002. Financial and ecological indicators of reduced impact

logging performance in the eastern Amazon. Forest Ecology and Management 163(2002):93-110.

3. Boltz, F., T.P. Holmes, and D.R. Carter. 2003. Economic and environmental impacts of conventional and reduced-impact logging in Tropical South America: a comparative review. Forest Policy and Economics 5(1):69-82.

4. Mercer, D.E. and S. Pattanayak. (forthcoming). Agroforestry adoption by smallholders. In: Abt, K. and E. Sills (eds.). Forests in a Market Economy. Kluwer, Dordrecht, Netherlands.

5. Mercer, E., J. Haggar, A. Snook, and M. Sosa. (forthcoming). Agroforestry Adoption in the Calakmul Biosphere Reserve, Campeche, Mexico. Journal of Crop Production.

6. Pattanayak, S. and D.E. Mercer. 2002. Indexing Soil Conservation: Farmer Perceptions of Agroforestry Benefits. Journal of Sustainable Forestry 15(2):63-85

7. Pattanayak, S. and D. E. Mercer. 1998. Valuing soil conservation benefits of agroforestry: contour hedgerows in the Eastern Visayas, Philippines. Agricultural Economics 18(1998):31-46.

## International trade policy analysis

### Key findings

Based on partial equilibrium models of trade, we found that trade liberalization in the Americas will have some impact on hardwood forest products exported from the U.S. and Canada to Mexico and the rest of the region. The principal effect of trade liberalization will be on U.S. exports of oak lumber, plywood, and veneer. When liberalization includes the rest of the Americas in a broader Free Trade Area of the Americas, the additional effects are tiny and relatively insignificant.

Although a common popular assertion is that trade liberalization encourages deforestation, Prestemon's analysis showed that NAFTA will have positive long-run effects on forest cover in Mexico but that this is net of losses on private lands.

The United States is the world's largest forest product producer and its second largest exporter, and research shows that this fact will remain the same for many decades into the future; however, the U.S. is likely to become relatively more reliant on imports than in the past.

### Implications

Environmental Impacts of trade liberalization are not straight-forward. Increased research is needed to determine direction of impacts under different conditions.

In order to more completely evaluate more accurately the effects of broadscale trade liberalization in the Western Hemisphere, partial equilibrium models need to better account for the effects of such liberalization on economy-wide variables such as costs of labor, capital, and energy; changes in forest product demand brought about by welfare changes; and shifts in the terms of trade (strength of the dollar relative to other currencies) caused by aggregate changes in cross-border flows of capital and goods.

### New questions

Can we do a better job of modeling timber supply in other countries than currently done in world trade models?

How are changes in U.S. trade likely to affect timber prices and land use choices in this and other countries?

### Key citations

1. Prestemon, J.P. 1998. The effects of NAFTA and an FTAA on U.S. exports of hardwood forest products. P. 35-44 In D. A. Meyer (ed.), Proceedings of the Twenty-Sixth Annual Hardwood Symposium, Technology and market information for the next millennium, May 6-9, 1998, Cashiers, North Carolina, National Hardwood Lumber Association.

2. Prestemon, J. P. 2000. Public open access and private timber harvests: theory and application to the effects of trade liberalization in Mexico. Environmental and Resource Economics 17:311-334. .

3. Prestemon, J.P., J. Buongiorno, D.N. Wear, and J. Siry. 2003. "International trade in forest products." In Sills, E., and K.L. Abt (editors), Forests in a Market Economy, Amsterdam: Kluwer.

### Related activities

The unit is currently funding cooperative agreements aimed at

- Better quantifying the effects of World Trade Organization-sponsored trade barrier reductions

- Evaluating how the principal product from timber growing in the U.S. South, southern pine lumber, responds to changes in Canadian softwood lumber imports.

## Distributive Impacts

### Key findings

In 1998, the Florida wildfires produced economic impacts of at least $600 million, similar in scale to recent category-2 hurricanes. Most of the damages were due to timber losses. Producers with undamaged timber gain in the long run while those with damaged timber and consumers of forest products lose in the long run. In Florida, prescribed burning is more common in rural areas with Caucasian dominated populations with lower average income, education, and age.

The US wood products industry continues to concentrate in the South, with 39.3% of all US wood products employment. Although economic indicators were negatively correlated with areas of high employment in the wood products industry, the woods products industry provided better paying jobs relative to other sectors in areas with a wood products industry. In contrast to areas with high forest recreation employment, forest industry concentration in the South also occurs in areas with low average education levels, high infant mortality, more owner occupied housing, and lower crime and divorce rates.

Empirical work suggests that conserving the Appalachian spruce-fir forests benefits all income levels. In fact, the percentage of income respondents willing to pay to conserve these forests decreased with income.

### Implications

Improved understanding of the interactions between management, wildfire, and its costs may yield large payoffs to society by identifying optimal intervention activities.

Areas of concentrated employment in forest recreation and tourism face different economic development challenges that areas with concentrated employment in wood products sectors.

Conserving the Appalachian spruce-fir forests may provide welfare gains to all socio-economic groups.

### New questions

Who pays and who gains from federal expenditures on wildland fire management and wildland presuppression activities such as vegetation management.

What are the distributive impacts of federal programs to encourage restoration and conservation of sensitive ecosystems?

### Key citations

1. Butry, D. T., D. E. Mercer, J. P. Prestemon, J. M. Pye, and T. P. Holmes. 2001. What is the price of catastrophic wildfire? Journal of Forestry 99(11):9-17.

2. Butry, D., J. Pye, and J. Prestemon. 2002. Prescribed fire in the interface: separating people from the trees. In: Outcalt, K.W. (ed.), Proceedings of the

Eleventh Annual Biennial Southern Silviculture Research Conference. General Technical Report SRS-48, USDA Forest Service, Southern Research Station, Asheville, NC. Pp. 132-136.

3.  Abt, K.L., S.A. Winter, and R.J. Huggett, Jr. 2002. Local Economic Impacts of Forests. In: Wear, D.W. and J.G. Greis (eds.), Southern Forest Resource Assessment, General Technical Report SRS-53, USDA Forest Service, Southern Research Station, Asheville, NC. Pp. 239-268.

4.  Holmes, T.P. 2002. Forests and the Quality of Life. In: Wear, D.W. and J.G. Greis (eds.), Southern Forest Resource Assessment, General Technical Report SRS-53, USDA Forest Service, Southern Research Station, Asheville, NC. Pp. 283-298.

5.  Aldy, J. E., R. A. Kramer, and T. P. Holmes. 1999. Environmental equity and the conservation of unique ecosystems: an analysis of the distribution of benefits for protecting Southern Appalachian spruce-fir forests. Society and Natural Resources 12:93-106.

6.  E. Mercer and P.B. Aruna. 2000. Assessing the Impacts of Forests on Human Welfare in the Mid-Atlantic Region. Journal of Environmental Monitoring and Assessment 63(1): 43-63.

### Related activities

The Unit received funding to manage a Joint Fire Sciences study (A National Study of the Economic Impacts of Biomass Removals to Mitigate Wildfire Damages on Federal, State, and Private Lands), which seeks to quantify how the federal government's 10-year strategy to mitigate wildfire damages could affect local and regional forest product markets and affect producers and consumers. An important part of the output from this study will be an assessment of how such a program on government lands will affect private land managers through timber price suppression and the potential stimulation of private investment in timber processing.

## Nonindustrial Private Forest Landowners

### Key findings

NIPF landowners place value on forestland for other than timber harvesting, although timber continues to be an important aspect of forest ownership and management. While NIPF owners do not manage as intensively for timber output as do industrial landowners, timber production from NIPF lands continues to be an important source of wood products. Other values held by NIPF owners include scenic beauty, wildlife habitat, recreation, and wetlands, and many are willing to pay for a portion of forest treatments to improve these values.

Forest land owners were significantly more likely to implement new stewardship practices, to increase personal non-reimbursed dollar expenditures, and to manage for multiple resource outputs when they also received follow up planning assistance and cost sharing for practice installation. Forest plans alone fostered improvements in stewardship behavior.

### Implications

The multiple objectives of NIPF landowners should be considered when modeling forest sustainability and when designing assistance programs. Values held by landowners are similar to reported values held for forests by the general public.

### New questions

What is the role of cost-shared NIPF plantations in current and future timber supplies? Are unthinned plantations contributing to fuels problems in the South? Have recent market shifts changed the willingness of landowners to participate in cost-sharing programs?

### Key citations

1. Esseks, J. D. and R. J. Moulton. 2000. Evaluating the Forest Stewardship Program Through a National Survey of Participating Forest Land Owners. De Kalb, IL: Center for Governmental Studies, Social Science Research Institute, Northern Illinois University. pages 1-111.

2. Scarpa, R., J. Buongiorno, J.-S. Hseu, and K.L. Abt. 2000. Assessing the non-timber value of forests: a revealed-preference, hedonic model. Journal of Forest Economics 6(2): 83-107.

3. Schaberg, R.H., T.P. Holmes, K.J. Lee, and R.C. Abt. 1999. Ascribing value to ecological processes: an economic view of environmental change. Forest Ecology and Management 114(1999):329-338.

4. Pattanayak, S., K. Abt, and T. Holmes. (in press). Timber and amenities on non-industrial private land. In: Abt, K. and E. Sills (eds.). Forests in a Market Economy. Kluwer, Dordrecht, Netherlands.

5. Cubbage, F.W., K.L. Abt, A.G. Snyder, and R.J. Moulton. (in press). Private forests: tenure, objectives and policy. In: Abt, K. and E. Sills (eds.). Forests in a Market Economy. Kluwer, Dordrecht, Netherlands.

6. Sills, E.O., T.P. Holmes, S.K. Pattanayak, and S. Lele. (in press). Non-timber forest products in the rural household economy. In: Abt, K. and E. Sills (eds.). Forests in a Market Economy. Kluwer, Dordrecht, Netherlands.

7. Abt, K.L. and J.P. Prestemon. (forthcoming). Optimal stand management. In: Abt, K. and E. Sills (eds.). Forests in a Market Economy. Kluwer, Dordrecht, Netherlands

### Related activities

A cost benefit analysis was prepared for the regulations enacting the Forest Land Enhancement Program as authorized by the Farm Bill 2002.

Nationwide tree planting reports and data collection efforts were managed from the Unit through the efforts of Dr. Robert Moulton, of the State and Private Forestry branch of the Forest Service.

Data from the tree planting reports were updated by Jeff Prestemon in the unit, with missing values from some states and years replaced in a scientific manner (using multivariate, dynamic models). The updated dataset was used in a figure of the Southern Forest Resource Assessment in the Timber Markets chapter of SFRA (Chapter 13) as one dimension of the long-term rise in timber investment in the South. Updated data have been requested by several members of the public.

# Annotated Publications FY1999 to FY2003

This section lists the 181 publications authored by Unit scientists, or based on research funded by the Unit, since fiscal year 1999 when our current Research Work Unit Description was officially adopted. The publications are organized by Problem Area and within that by publication year and author name.

## Assessment of Southern Timber Markets

### 1998 (1)

Abt, R. C., F. W. Cubbage, et al. (1998). "Timber Supply: Mississippi and the South." <u>Tree Talk (Jackson, MS)</u> Winter: 15-20.

> The availability of timber has become an issue across the South as supplies from other regions are constrained and as demand for timber continues to grow. While any individual state or landowner will have a small impact on national timber supplies, the availability of local timber will have a profound effect on local industries. In Mississippi, for example, furniture manufacturing requires large-diameter hardwoods and when not available locally, this industry must find alternative sources of timber, alter production to reduce wood requirements, or, in the worse case, it will not be able to compete nationally.

### 1999 (11)

Aruna, P. B. and D. E. Mercer (1999). The timber economy of the Mid-Atlantic Region: some preliminary results from the Mid-Atlantic Integrated Assessment. <u>Proceedings of the 1998 Southern Forest Economics Workshop</u>, Research Triangle Park, NC, Southern Research Station.

> The Mid-Atlantic Integrated Assessment (MAIA) is a multi-agency effort headed by the USEPA to assess the health and sustainability of ecosystems in an 8 state region. We present some preliminary results on the economic impact of forest industries from the socio-economic component of the MAIA forest assessment. Employment and income trends between 1975-1995 are examined for three specific sectors of the economy in the Mid-Atlantic region: (1) Lumber and Wood Products - Standard Industry Classification (SIC) 24, (2) Paper and Allied Products - SIC 26, and (3) Furniture and Fixtures - SIC 25. During the last two decades, forest based industries in the MAIA produced an average of 244,100 jobs and $4.5 billion in real wages per year, or about 2 percent of all wage employment and income in the MAIA region. However, during this time period the forest industry sector has generally not grown as rapidly as the rest of the MAIA economy (with the exception of SIC 24 in Delaware, West Virginia, and Pennsylvania and SIC 25 in Delaware) and several states have even experienced negative rates of growth in their forest industry sectors. If recent trends continue, forest industry will continue to be an important source of employment and income for parts of some states in the MAIA region; however, forest industry's importance relative to the entire Mid-Atlantic economy will continue to decline in the 21st century.

Bingham, M., D. MacNair, et al. (1999). Structural change and co-integration in southern timber prices. <u>Proceedings of the 1998 Southern Forest Economics Workshop</u>, Research Triangle Park, NC, Southern Research Station.

> The objective of this research is the empirical evaluation of factors influencing price linkages in Southern timber prices. The analysis focuses on the factors that affect cointegration. The results lead to a better understanding of Southern timber price relationships over time and space and across products. The primary research methods are cointegration tests and minimum chi-squared analysis. Cointegration tests have been used to assess market efficiency and integration in timber markets. However, the relationship between price cointegration and market integration is generally

unclear. Minimum chi-square analysis provides the basis for better understanding of the relationship between cointegration probabilities and variables describing market characteristics.

Carter, D. R. (1999). Structural change in Southern softwood stumpage markets. <u>Proceedings of the 1998 Southern Forest Economics Workshop</u>, Williamsburg, VA, Southern Research Station, USDA Forest Service.

The potential for structural change in southern stumpage market models has impacts on not only our basic understanding of those markets, but also on harvest, inventory and price projections, and related policy. In this paper, we test for structural change in both sawtimber and pulpwood softwood stumpage markets in the U.S. South over the period 1950-1994. Test results strongly reject structural stability in both sawtimber and pulpwood supply over the period. However, stability in stumpage demand can not necessarily be rejected. Using a new technique, Flexible Least Squares (FLS), a series of varying elasticity models are estimated. Results of the FLS procedure show that both pulpwood and stumpage price supply elasticities have been trending upward over time. The degree of this trend depends upon whether a linear or log-linear model is specified.

Cubbage, F. W., J. Siry, et al. (1999). Forest productivity and timber supply modeling in the South. <u>Conference Proceedings: Improving Forest Productivity for Timber</u>, Duluth, MN.

The South can increase forest productivity on industrial and nonindustrial private forest (NIPF) lands. As timber markets have improved and timber prices have increased, returns from intensive management are more profitable. The interaction of timber markets, inventory, and prices are analyzed in new southern timber supply models sponsored by the Southern Forest Resource Assessment Consortium (SOFAC). Current SOFAC efforts have focused on integrating southern models and model inputs with the national Renewable Resource Planning Act (RPA) timber assessment. SOFAC researchers have developed timber supply models that can analyze timber markets trends at the subregional (survey unit) level. Growth and yield analyses prepared for the RPA indicate that substantial increases in timber productivity can occur given current technology, if fully implemented. A survey about NIPF land management practices indicates that considerable adoption of increased management intensities is projected to occur. Even higher intensities can occur on forest industry lands in the South. If these potentials are realized, we will be able to provide adequate pine pulpwood supplies at reasonable prices in the future. High quality softwoods and hardwoods will be less plentiful. Hardwood timber supply will be relatively scarcer in the future, as reflected in increasing real prices, despite having almost 50% more standing inventory than softwoods currently.

Moffat, S., F. W. Cubbage, et al. (1999). The future of forest management on NIPF lands in the South: results of an expert opinion survey. <u>Proceedings of the 1998 Southern Forest Economics Workshop</u>, Research Triangle Park, NC, Southern Research Station.

A survey was sent to each state forester in the 13 states in the Southeast and South Central Regions to ask their opinions regarding the future of forest management on NIPF lands in their state. The results indicate that changes are in store for NIPF lands between now and 2020. Planted pine is projected to increase 7% in area in the South, largely at the expense of natural pine, which is projected to decrease in area by 6%. The amount of land in the other forest types will remain relatively constant, although there will be significant shifts among forest types during the period. Management intensity is projected to increase dramatically, with more intensive practices being applied to all five forest management types - - even to upland hardwood stands (a 5% increase) - - with planted pine showing the greatest shift with a 22% increase to very high intensity management region-wide. A gradual reduction in the amount of land available for management is predicted to occur, with losses of 1% in the planted pines to an 11% decrease in bottomland hardwoods. Clearcutting is projected to decrease in the Southeast by 10% in pine plantations and 42% on upland hardwood sites. It is projected to increase slightly in the South Central by 1% to 3% for all five forest management types. Factors most likely to limit increases in productivity are tied to population growth and changes in owner objectives.

Moulton, R. J. (1999). Why plant trees<u>? Proceedings of enhancement of reforestation at surface coal mines: technical interactive forum</u>. Carbondale, IL, Southern Illinois University, Coal Research Center.

This forum features an outstanding slate of experts on the science and art of reforesting strip mined lands. They will give you information on the status of reforestation efforts and the latest on

emerging new technologies, address how to overcome barriers, and talk about opportunities. This paper does not address these topics. Rather, its purpose is to establish the forestry context--to set the stage for OSM/State reforestation efforts by providing an overview of the extent, condition, trends, and importance of America's forest resources and to provide an overview of tree planting in the United States.

Prestemon, J. P. and D. N. Wear (1999). Inventory effects on aggregate timber supply. <u>Proceedings of the 1998 Southern Forest Economics Workshop</u>, Research Triangle Park, NC, Southern Research Station.

Separate literatures exist to describe responses of timber owners and aggregate timber supply to product prices. While few investigators have alluded to the effects of varying inventory quality and ownership mix on the aggregate response, it is possible to describe how the responsiveness to prices can vary over time as the vintage of the timber inventory shifts. We estimated a probit harvest model using stand-level periodic forest inventory data and modeled the effects of price changes on aggregate supply. The stand-level data were obtained from futed plots from loblolly pine stands in the coastal plain of North Carolina. By applying the estimated harvest decision model to each stand and multiplying product volumes by associated area expansion factors, we observed the effects of price perturbations on aggregate harvest quantities. The harvest model included data on sawtimber and pulpwood volumes, which enabled a simulation of the effects of changes in either product price or inventory characteristics on the production of pulpwood and sawtimber. To illustrate the effects of varying inventory characteristics, we evaluated harvest responsiveness in two periods. First, we calculated the supply elasticity with respect to price given the inventory of 1983-1989. Then, using alternative estimates of timber supply characteristics existing in 1995, we estimated the supply elasticity with respect to price given the inventory of 1989-1995. Differences in supply responses between the two periods are traced to evolving inventory vintages and changing quantities of inventory under NIPF and industry management.

Teeter, L. and X. Zhou (1999). A multinomial logit approach to estimating regional inventories by product class. <u>Proceedings of the 1998 Southern Forest Economics Workshop: Part II</u>, Research Triangle Park, NC, Southern Research Station.

Current timber inventory projections generally lack information on inventory by product classes. Most models available for inventory projection and linked to supply analyses are limited to projecting aggregate softwood and hardwood. The objective of this research is to develop a methodology to distribute the volume on each FIA survey plot to product classes and simulate the changes in the product distribution over time. A multinomial logit model was developed to estimate sets of product proportion functions to distribute plot volumes by product class for each forest type and size class. The product proportion model is incorporated in the DPSupply system, and is demonstrated using Alabama data.

Teeter, L. and X. Zhou (1999). "Projecting Timber Inventory at the Product Level " <u>Forest Science</u> 45(1): 226-231.

Current timber inventory projections generally lack information on inventory by product classes. Most models available for inventory projection and linked to supply analyses are limited to projecting aggregate softwood and hardwood. The research presented describes a methodology for distributing the volume on each FIA (USDA Forest Service Forest Inventory and Analysis) survey plot to product classes given a type characterization, volume, and average dbh (diameter at breast height, 1.37 m above average ground level) for the plot. A multinomial logit model was developed to estimate sets of product proportion functions to distribute plot volumes by product class for each forest type and size class. A discussion of the performance of the model using Alabama and Mississippi FIA plot level data is provided.

Wagner, J. E. and T. P. Holmes (1999). "Estimating economic gains for landowners due to time-dependent changes in biotechnology " <u>Forest Science</u> 45(2): 163-170.

This paper presents a model for examining the economic value of biotechnological research given time-dependent changes in biotechnology. Previous papers examined this issue assuming a time-neutral change in biotechnology. However, when analyzing the genetic improvements of increasing a tree's resistance to a pathogen, this assumption is untenable. The authors derive analytical expressions for the optimal rotation age given non-constant changes in biotechnology. Their model

is then implemented using (1) growth and yield simulations; (2) optimal rotation calculations; and (3) survey data on genetic resistance of slash pine (Pinus elliottii) to fusiform rust. Non-parametric regression models are used to estimate the economic gain functions which, for the cases considered, averaged about 1 percent of forestland value per year.

Yin, R. and D. H. Newman (1999). "A timber producer's entry, exit, mothballing, and reactivation decisions under market risk." Journal of Forest Economics 5(2): 305-320.

This paper examines the investment decisions of a timber producer when the output price follows a continuous-time stochastic process. We find that these decisions take the form of a set of trigger prices. While the optimal entry price exceeds its static counterpart - the long-run average total cost, the optimal exit price is less than its static counterpart - the short-run average variable cost. Further, as market conditions evolve, the producer has other decisions like mothballing or reactivation to consider before abandoning production. Our empirical example illustrates how these decisions may vary even with a moderate degree of price volatility, a small amount of sunk costs, and changes in other parameters. Our work gives better explanations to some important issues in forest investment.

# 2000 (10)

Abt, R. C., F. W. Cubbage, et al. (2000). "Southern forest resource assessment using the Subregional Timber Supply (SRTS) model." Forest Products Journal 50(4): 25-33.

Most timber supply analyses are focused on broad regions. This paper describes a modeling system that uses a standard empirical framework applied to subregional inventory data in the South. Model results indicate significant within-region variation in supply responses across owners and regions. Projections of southern timber markets indicate that results are sensitive to: 1) estimates of current harvest; 2) conversion of natural stands to plantations; and 3) growth rates associated with plantations. Given projected increases in demand, intensive pine managemnet could ameliorate real prices increases. For hardwoods, uncertainty about the viability of intensive management or imports makes supply response projections less conclusive.

Leffler, K. B., R. R. Rucker, et al. (2000). "Transaction costs and the collection of information: presale measurement on private timber sales." Journal of Law, Economics and Organization 16(1): 164-186.

Measurement efforts to reduce the uncertainty concerning the attributes of heterogeneous goods may simply redistribute wealth and result in social waste. Individuals bearing the cost of such distributional measurement have incentives to develop buying and selling practices that limit such measurement. We examine, both theoretically and empirically, the determinants of the level of distributional measurement efforts in a competitive auction framework. The empirical application, which uses a sample of private timber sales, provides strong support for the implications of the theoretical model of presale measurement.

Prestemon, J. P. and J. Buongiorno (2000). "Determinants of tree quality and lumber value in natural uneven-aged southern pine stands." Canadian Journal of Forest Research 30(2): 211-219.

An ordered-probit model was developed to predict tree grade from tree- and stand-level variables, some of which could be changed by management. Applied to uneven-aged mixed loblolly (Pinus taeda L.) - shortleaf pine (Pinus echinata Mill.) stands, the model showed that the grade of pine trees was highly correlated with tree diameter, tree height, and stand basal area, in non-linear fashion. In addition, a tree was more likely to be of high quality if it grew on industry or government forestland, on poorer sites, and in stands that had been partially cut in the past. However, the effects of changes in these variables on the unit value of recovered lumber were small. The exceptions were tree diameter and height, which were the most important indicators of lumber value.

Prestemon, J. P. and J. M. Pye (2000). Merging areas in Timber Mart South data. Proceedings of the 1999 Southern Forest Economics Workshop, Starkville, MS, Mississippi State University, Department of Forestry.

For over twenty years, Timber Mart-South (TMS) has been distributing prices of various wood products from Southern forests. These long-term price series have been a critical resource for research into timber price and supply trends in the southern United States. Such analyses rely on consistent temporal and spatial reporting units, but these units have not always been consistent for many TMS reporting series. In the beginning of 1988 the reporting frequency changed from monthly to quarterly, a change readily addressed through a variety of statistical techniques. A more significant statistical challenge is Timber Mart-South's change in 1992 from (typically) three reporting regions per state to two. We developed a conversion technique to address this change in reporting areas, permitting longitudinal analyses of the current two regions per state but extending back to the beginning of Timber Mart-South's reports in 1976. We report conversion factors for every state's regions, verify the statistical nature of all timber series created using them, and report tests of seamlessness. We find that our technique enables the creation of new, seamless series for pine sawtimber stumpage and delivered sawlogs, and pine and hardwood pulpwood stumpage and delivered logs. In only a few cases were we able to identify remaining regime shifts in the time-series of quarterly prices that corresponded with the 1992 boundary reconfigurations. However, these statistically significant shifts may not be related to the boundary reconfigurations.

Prestemon, J. P. and J. M. Pye (2000). "A technique for merging areas in Timber Mart-South data " Southern Journal of Applied Forestry 24(4): 219-229.

For over twenty years, Timber Mart-South (TMS) has been distributing prices of various wood products from Southern forests. In the beginning of 1988 the reporting frequency changed from monthly to quarterly, a change readily addressed through a variety of established statistical techniques. A more significant statistical challenge is Timber Mart-South's change in 1992 from (typically) three reporting regions per state to two. We developed a conversion technique to address this change in reporting areas, permitting longitudinal analyses of the current two regions per state but extending back to the beginning of Timber Mart-South's reports in 1976. We report conversion factors for every state's regions, verify the statistical nature of all time series created using them, and report tests of seamlessness. We find that our technique enables the creation of new, seamless series for pine sawtimber stumpage and delivered sawlogs, and pine and hardwood pulpwood stumpage and delivered logs. In only 30 out of 126 cases were we able to identify remaining regime shifts in the time-series of quarterly prices that corresponded with the 1992 boundary reconfigurations. However, these statistically significant shifts may not be related to the boundary reconfigurations.

Prestemon, J. P. and D. N. Wear (2000). "Linking harvest choices to timber supply." Forest Science 46(3): 377-389.

Aggregate timber supply by ownership was investigated for a small region by applying stand-level harvest choice models to a representative sample of stands and then aggregating to regional totals using the area-frame of the forest survey. Timber harvest choices were estimated as probit models for three ownership categories in coastal plain southern pine stands of North Carolina using individual permanent and remeasured stand-level data from last two available U.S. Forest Service Forest Inventory and Analysis (FIA) surveys. The timber harvest decision was modeled as a function of timber values, a cost factor, and stand volume as a proxy for non-timber values. Probit models were statistically significant at 1% for all ownerships. Area expansion factors (the portion of forest area in the region represented by the sampled stand) were then combined with harvest probabilities to model the aggregate effects of price changes on timber supply, given a fixed forest area. Implied price elasticities were estimated using this modeling of aggregate effects, and a bootstrapping procedure was applied to estimate confidence limits for supply elasticities with respect to price. Our results showed that NIPF and industry were elastically responsive in the aggregate when price increases are perceived as temporary but much less elastically and usually negatively responsive when increases are perceived as permanent. Results are consistent with theory of optimal rotations and highlight the critical influence of both existing inventory structure and expectations on aggregate timber supply.

Raunikar, R., J. Buongiorno, et al. (2000). Biological and economic productivity of mixed-aged loblolly pine stands in the South. Proceedings of the 1999 Southern Forest Economics Workshop, Starkville, MS, Mississippi State University, Department of Forestry.

The financial performance of the 991 sample plots of uneven-aged loblolly-hardwood stands in the Central South FIA database examined in this report depend crucially on real price trends.

Equivalent annual income (EAI) is the measure of economic performance. The regional market stumpage price data are from the Timber Mart-South database. For this set of prices, a higher real price level prevailed in most of the regional markets after 1993. The mean EAI was $56/ac/yr most of which was due largely to the favorable trend in real timber prices. The mean EAI with the real price maintained at the starting price was $10/ac/yr. The increasing real price trend during the study period dominated all other factors in determining financial performance. With this increasing price trend, the best performing lands are overstocked stands and the opportunity cost of conservation is negative. Constant price EAI is affected significantly by the stand basal area, total number of trees, number of hardwood trees, and number of trees near saw timber size. The effect of some factors on constant price EAI is significantly stronger on publicly held lands than on privately held lands. No difference between the financial performance of industrially owned lands and other privately held lands is apparent.

Raunikar, R., J. Buongiorno, et al. (2000). "Financial performance of mixed-age naturally regenerated loblolly-hardwood stands in the South Central United States." <u>Forest Policy and Economics</u> 1(3/4): 331-346.

To estimate the financial performance of a nature-oriented mixed species and mixed-age management in the loblolly-pine forest type, we examined 991 FIA plots in the Central South states. The plots were of the loblolly pine forest type, mixed-age, and had been regenerated naturally. They typically included oak and hickory in a mix from 86 species of hardwoods and 9 species of softwoods.  Most of the plots were on lands of small private owners, but a substantial number belonged to industry or were on public lands.  we gauged the financial performance of each plot using the equivalent annual income (EAI) produced by growth and harvest, between two successive inventories.  The real price EAI measured the financial performance including the real price change between surveys.  The constant price EAI measured stand productivity at prices at the time of the first survey.  During the period 1977-1994, the main determinant of the real price EAI was the price change.  Due to an overall favorable price trend, the mean real price EAI ($138 ha-1yr-1) was much greater than the mean constant price EAI ($25 ha-1yr-1).  Because of increasing prices, the best performing plots had very high stocking levels.  Thus, the best financial strategy was to hold the stock, making the opportunity cost of conservation negative.  Instead, constant price EAI tended to be lower on stands with high basal area, and higher in stands with many trees, a low share of hardwoods, and many trees near sawtimber size.  At constant prices, the productivity of mixed-age naturally regenerated loblolly-hardwood stands in the Central South was similar to that of Wisconsin northern hardwoods.

Siry, J. P., F. W. Cubbage, et al. (2000). Potential impacts of increased management intensities on planted pine growth and yield and timber supply modeling in the South. <u>Proceedings of the 1999 Southern Forest Economics Workshop</u>, Starkville, MS, Mississippi State University, Department of Forestry.

The South can increase pine productivity on its forest lands as increased timber prices make returns from intensified forest management more profitable. We determined the most likely management intensities on industrial lands resulting in five management intensity classes. They are used to estimate the potential growth and yield levels, and compare these to empirical pine yields, developed as a part of the SRTS model inputs and based on Forest Inventory Analysis (FIA) data. These comparisons indicate that projected plantation yields are much greater than empirical FIA data--almost 100% greater than current empirical yields. Projected yields were also up to 90% higher than those used in the 1995 Rangeland Renewable Resource Act (RPA) assessment. If realized, such productivity increases could prevent timber shortages. Financial analyses indicate that intensified forest management is economically feasible and offers attractive returns.

Wear, D. N. (2000). Regional assessment and interregional comparisons of forest investment. <u>Proceedings of the 1999 Southern Forest Economics Workshop</u>, Starkville, MS, Mississippi State University, Department of Forestry.

Because forestry is a long term production activity, every management activity (even inactivity) can be construed as an investment. Accordingly, assessing the level of investment within a dynamic region such as the South is a substantial challenge. Likewise, it is difficult to construct meaningful comparisons of investment across regions, especially when regions have distinct forest types with distinct growth rates and investment responses. But this is exactly what is called for in international agreements on forest sustainability- most notably, the Santiago Declaration. This paper explores various approaches to developing regional indicators of forest investment. These approaches are

compared using readily available forest inventory data compiled at various levels of aggregation. Investment is then compared across parts of the South and between the South and other regions of the United States. Results highlight the increasing dominance of the South in the wood products industry.

# 2001 (8)

Buongiorno, J. and Southern Research Station (Asheville N.C.). (2001). "Generalization of Faustmann's formula for stochastic forest growth and prices with Markov decision process models." <u>Forest Science.</u>  47(4): 466-474.

Faustmann's formula gives the land value, or the forest value of land with trees, under deterministic assumptions regarding future stand growth and prices, over an infinite horizon. Markov decision process (MDP) models generalize Faustmann's approach by recognizing that future stand states and prices are known only as probabilistic distributions. The objective function is then the expected discounted value of returns, over an infinite horizon. It gives the land or the forest value in a stochastic environment. In MDP models, the laws of motion between stand-price states are Markov chains. Faustmann's formula is a special case where the probability of movement from one state to another is equal to unity. MDP models apply whether the stand state is bare land, or any state with trees, be it even- or uneven-aged. Decisions change the transition probabilities between stand states through silvicultural interventions. Decisions that maximize land or forest value depend only on the stand-price state, independently of how it was reached. Furthermore, to each stand-price state corresponds one single best decision. The solution of the MDP gives simultaneously the best decision for each state, and the forest value (land plus trees), given the stand state and following the best policy. Numerical solutions use either successive approximation, or linear programming. Examples with deterministic and stochastic cases show in particular the convergence of the MDP model to Faustmann's formula when the future is assumed known with certainty. In this deterministic environment, Faustmann's rule is independent of the distribution of stands in the forest.

Das, G. and J. Alavalapti (2001). Biotechnological innovations in the forestry sector and their economic impacts on other sectors via embodied technology transfer:  an investigation within dynamic GTAP framework. <u>Proceedings of the Fourth Annual Conference on Global Economic Analysis</u>, West Lafayette, IN, Purdue University.

In this paper, we consider technology transfers embodied in trade flows within a seven-region, seven-traded-commodity version of the dynamic GTAP model.  0.63% Hicks-Neutral technical progress in forestry sector (logging) in source regions has differential impacts on productivity of the logging-user sectors.  This is ascribed to the differential rates of induced technology transmission via traded intermediates.  Destination regions' ability to utilize new technology depends on their *absorptive capacity* (AC) *and structural similarity* (SS).  Together with trade flows, these two factors determine the recipient's success in assimilating foreign technology.  Sectors intensive in logging like wood products, paper products, publishing register higher productivity growth. Differences in productivity improvements depend on the differentials in the magnitude of technology capture.

Fina, M., G. S. Amacher, et al. (2001). "Uncertainty, debt, and forest harvesting: Faustmann revisited." <u>Forest Science</u> 47(2): 188-196.

Debt is a common feature of forestland ownership, yet it has not been formalized in previous work on uncertainty and forestry decision-making. We extend Faustmann-based price search models by introducing a debt obligation that landowners feel pressure to pay off in finite time. We assume a price arrival process that is more general then in previous search models and allows for multiple unknown offers each period. The motivation for paying off debt could be the high costs of searching for another price offer, costs of renegotiating or refinancing debt, increasing interest charges, or landowner preferences for eliminating debt. The decision problem and associated reservation price strategy depend on a comparison of costs and benefits of waiting to harvest. The timing of debt-payoff date is the critical feature of our model. We show that a debt-payoff date implies a certain path of reservation prices over time and ultimately effects harvesting behavior. The direction and magnitude of effect depends on forest maturity. We also investigate how the reservation price-debt payoff date relationship depends on debt in future rotations, nontimber income, amenity benefits, and single versus infinite rotations. Although these ideas, particularly the inclusion of amenities

and nontimber income, are absent from the conventional price search literature, we show they have important effects on the optimal reservation price strategy when landowners feel pressure to pay off debts in finite time.

Nagubadi, V., I. A. Munn, et al. (2001). "Integration of hardwood stumpage markets in the Southcentral United States." Journal of Forest Economics 7(1): 69-98.

The law of one price is tested using Johansen's simultaneous multivariate cointegration framework and the question of market integration is examined for hardwood pulpwood, mixed hardwood sawtimber, and oak sawtimber in six states (Alabama, Arkansas, Louisiana, Mississippi, Tennessee, and Texas) using quarterly real stumpage prices from 1977 to 1997. The main finding is that the law of one price is not applicable and markets are not fully integrated for any of these hardwood stumpage commodities. The implication is that the six states in this region can not be treated as single market for these commodities. Hardwood pulpwood markets are less integrated than hardwood sawtimber markets. There is evidence for three separated markets for hardwood pulpwood, and for two separated markets for each of mixed hardwood and oak sawtimber.

Prestemon, J. P., J. M. Pye, et al. (2001). Timber economics of natural catastrophes. Proceedings of the 2000 Southern Forest Economics Workshop, Monticello, Arkansas, School of Forest Resources, University of Arkansas.

The United States regularly suffers losses of timber from a variety of catastrophic events, including hurricanes, wildfires, ice storms, and pest outbreaks. Such catastrophes can hurt timber producers through their effects on production, and prices if damages are widespread. These two forms of risk, production and price, have traditionally been examined independently of each other, but when damages are widespread the risks to production and price are not independent, they are joint. The joint nature of the risks substantially complicates the optimal response of landowners to such risks. Clarifying the implications of this joint risk is the central point of this paper. Fine-scaled events can cause investment losses to owners of killed timber but when catastrophes are widespread, salvage activities across a landscape depress prices and inventories, expanding the impacts to producers of timber undamaged by the event. While salvage gluts drive down prices in the near term and depress inventories, longer-term inventory effects can increase prices even higher than before. This would imply that when disasters first strike, owners of undamaged timber should delay harvesting, but some disturbance agents have temporal and spatial autocorrelations, which affect their medium-term production and price risks, complicating this simple rule of thumb. When disasters are prolonged over several years, as often happens with southern pine beetle, owners of undamaged timber must weigh the promise of future price rebounds against the increased production risks faced during those years of delay. Other agents have different temporal and spatial characteristics, this paper outlines the implications of these characteristics on the joint nature of price and production risk and their implications for optimal harvest decisions.

Rogers, W. R. (2001). Determining annual forest management activities and expenditures: a survey of TIMOs and industrial landowners in Mississippi during 1998-1999. Thesis, Forestry Department, Mississippi State University. 83 pp.

Snider, A., F. Cubbage, et al. (2001). Potential effects of wood chip mill harvests on economic returns and forest management practices of nonindustrial private forest landowners in North Carolina. Proceedings of the 2000 Southern Forest Economics Workshop, Monticello, Arkansas, School of Forest Resources, University of Arkansas.

Four approaches were used to estimate the market effects of wood chip mills for nonindustrial private forest (NIPF) landowners. First, we used economic welfare analyses to estimate potential changes in consumer and producer surplus that might be attributed to increased stumpage demand created by wood chip mills. Better markets would consistently increase economic returns for both timber buyers and sellers, up to about $5 million per year more per 1% shift outward in the demand function. Forest industry (buyers) had higher benefits in absolute terms, while NIPF owners (sellers) had higher percentage benefits. Second, changes in actual returns in the 1990s were estimated using Timber Mart-South data and timber product output (TPO) measures of changes in harvest levels. NIPF owners had decreased returns from softwood stumpage sales.

Yin, R. and R. A. Sedjo (2001). "Is this the age of intensive management? a study of loblolly pine on Georgia's Piedmont." Journal of Forestry 99(12): 10-17.

Using data for loblolly pine from Georgia's Piedmont, we find that, although the transition from natural to artificial regeneration leads to increased and better distributed stems, the control of competing vegetation results in a dramatic boost to the growth rate from previous- to current-generation plantations. Our results indicate that the marginal returns of forest management are increasing rather than diminishing; the more intensive the management, the better its economic performance. These findings suggest that intensive management represents a major technical change and bodes well for the future of commercial forestry in the South.

# 2002 (7)

Arano, K. G., T. L. Cushing, et al. (2002). "Forest management expenses of Mississippi's nonindustrial private forest landowners." Southern Journal of Applied Forestry 26(2): 93-98.

Detailed information about the forest management expenditures incurred by nonindustrial private forest (NIPF) landowners over time provides a wealth of information about costs associated with forestland ownership, management practices implemented by NIPF landowners, and changes in management intensity over time. A survey of Mississippi's nonindustrial private forest (NIPF) landowners owning 20 ac or more of forestland was conducted to determine their annual expenditures on forest management practices for the period 1995-1997. Landowners were asked how much they spent on property taxes, professional services, timber management activities, and other management activities. The resulting expenditures data were summarized in three ways: frequency of occurrence, mean expenditures per-acre-owned for all respondents, and mean expenditures per-acre-owned for those respondents engaged in each activity. With the exception of property taxes, most expenditures occur infrequently. Fewer than 15% of all respondents incurred expenditures for any specific activity during any survey year. Total annual expenditures for all respondents average $9.68/ac-owned over the study period. Across all landowners, property taxes represented the largest component of annual expenditures with planting costs and consulting forester fees ranking second and third. Mean expenditures for only those respondents engaged in each activity told a slightly different tale. Planting and consulting forester fees were the two largest expenditures, but site preparation, timber cruising, timber marking, and surveyor fees were all greater than property taxes for those engaged in these activities.

Luppold, W. G., J. P. Prestemon, et al. (2002). Changing markets for hardwood roundwood. Proceedings of the 2001 Southern Forest Economics Workshop, Auburn, AL, School of Forestry and Wildlife Sciences, Auburn University.

Traditionally, hardwood roundwood has been used to produce lumber, cabinet plywood, and veneer. Hardwoods also have been a major part of the pulpwood consumption in the northern tier of the eastern United States since the early 1960's, while southern pines have been the predominant species used in southern tier states. However, since the 1960's there has been a steady increase in the consumption of hardwood pulpwood in the East. During the mid 1980's, hardwood roundwood also started to be used for the production of engineered wood. By the early 1990's, the volume of hardwood roundwood consumed by the pulp and EWPs industries exceeded the volume of roundwood consumed by the hardwood lumber industry. The consumption of eastern hardwood roundwood has increased dramatically in part because there are substantial hardwood resources to support this increase. Other factors that have influenced the increase include declining volumes of southern softwood growing stock, reduction in the sale of softwood timber from National Forests, and rising demand for homes and paper. These factors caused the price of softwood roundwood to escalate and provided the impetus needed to develop new technologies to manufacture products from less expensive hardwood roundwood. Still, changes in hardwood roundwood consumption have varied by region. In this paper we analyze changes in hardwood roundwood consumption on a regional level and how they were influenced by increasing demand for wood-based materials, increased volumes of hardwood inventories, and changes in technology.

Prestemon, J. P. and R. C. Abt (2002). "The southern timber market to 2040." Journal of Forestry 100(7): 16-22.

Timber market analysis of the South's predominantly private timberland finds that the 13 southern states produce nearly 60 percent of the nation's timber, an increase from the mid-1900s.

Projections with the Subregional Timber Supply model show that, despite a 60 percent increase in the area of pine plantations, the South will experience a 1 percent decline in private timberland area as other forest types shrink. Because of expected productivity gains for plantation forests and conversions of some agricultural lands to natural forests, the South's industrial wood output is projected to increase by more than 50 percent between 1995 and 2040

Rogers, W. R. and I. A. Munn (2002). Annual forest management activities of TIMOs and Industrial landowners in Mississippi during 1998-1999. <u>Proceedings of the 2001 Southern Forest Economics Workshop</u>, Auburn, AL, School of Forestry and Wildlife Sciences, Auburn University.

This study reports results from a survey of timberland investment management organizations (TIMOs) and industrial timberland owners in Mississippi during 1998-1999. Respondents were asked to report acres owned by forest type, silvicultural treatments, and regneration and harvest information. Results provide information on how TIMOs and industrial landowners manage their timberland annually. Additionally, evidence suggests TIMOs and large industrial landowners manage their lands similarly.

Schulte, B. J. and J. Buongiorno (2002). Nonlinear programming models to optimize uneven-aged shortleaf pine management. <u>Proceedings of the eleventh biennial southern silvicultural research conference</u>. K. W. Outcalt. Knoxville, TN, U.S. Department of Agriculture, Forest Service, Southern Research Station. SRS-48: 448-453.

Nonlinear programming models of uneven-aged shortleaf pine (*Pinus echinata* Mill.) management were developed to identify sustainable management regimes that optimize soil expectation value (SEV) or annual sawtimber yields. The models recognize three species groups (shortleaf pine and other softwoods, soft hardwoods and hard hardwoods) and 13 2-inch diameter-at-breast-height size classes. Reproduction, growth and mortality rates are a function of tree diameter, stand density and site productivity. The optimal economic and production regimes each involve a guiding maximum diameter for softwoods and periodic hardwood control, with the optimal maximum diameter a function of site productivity.

Siry, J. P. and F. W. Cubbage (2002). A survey of timberland investment management organizations forestland management in the South. <u>Proceedings of the 2001 Southern Forest Economics Workshop</u>, Auburn, AL, School of Forestry and Wildlife Sciences, Auburn University.

The assets of Timberland Investment Management Organizations (TIMOS) have rapidly grown over the past two decades, indicating their increasing importance for timber supply in the South. A TIMOS survey was conducted to assess their current and future investments and forest management approaches. The results indicate that TIMOS currently hold about 4.2 million acres of forestland in the region. Planted pine dominates their holdings, accounting for 69% of the land. Its share is expected to increase, primarily as a result of forest conversion and/or future land transactions. Over time, planted pine management intensities are predicted to increase substantially. Natural pine, oak-pine, and hardwood forests are managed much less intensively. The survey's results also indicate that TIMOS forest management is similar to the forest industry (FI). TIMOS have impressive growth plans and intend to increase their holdings to 12.2 million acres by 2010. This expansion to large extent depends on the availability of land appropriate for acquisition and appears feasible provided that FI will continue to divest its timberland.

Wu, L., J. Alavalapati, et al. (2002). Assessing the impact of trade policy and technology changes in the U.S. forestry sectors. <u>Proceedings of the 2001 Southern Forest Economics Workshop</u>, Auburn, AL, School of Forestry and Wildlife Sciences, Auburn University.

Increased trade liberalization and globalization of financial markets are influencing both the demand for and supply of forest products in the U.S. Meanwhile, more innovations are introduced into the U.S. forestry sectors to meet the growing demands for forst products. Since the U.S. is the largest producer and consumer of forest products in the world, these changes are expected to have significant implications for forestry sectors across the world. This study aims at (1) estimating the impacts of forest products trade liberalization on the U.S. forestry sectors; (2) examining the effect of technological progress in the U.S. forestry production relative to the rest of the world. A multi-regional multi-sectoral applied global general equilibrium model is employed to achieve the goal. Results of the study have implications for better production and marketing decisions as well as policy prescriptions related to sustainable forest management in the U.S.

# 2003 (1)

Abt, K. L. and J. P. Prestemon (2003). Chapter 4:  optimal stand management:  traditional and neotraditional solutions. Forests in a market economy. E. Sills and K. L. Abt. Dordrecht, Netherlands, Kluwer Academic Publishers: 41-57.

Bingham, M. F., J. P. Prestemon, et al. (2003). "Market structure in U.S. southern pine roundwood." Journal of Forest Economics 9(2): 97-117.

Time series of commodity prices from multiple locations can behave as if responding to forces of spatial arbitrage, even while such prices may instead be responding similarly to common factors aside from spatial arbitrage.  Hence, while the Law of One Price may hold as a statistical concept, its acceptance is not sufficient to conclude market integration.  We tested the factors hypothesized as linked to integration of forest products markets by applying a combination of bivariate and multivariate techniques.  Bivariate cointegration tests were conducted for price pairs among 21 price regions and were done for both delivered southern pine sawlogs and delivered southern pine pulpwood logs.  Multivariate meta-analytic regressions of cointegration test results on hypothesized explanatory factors were run for pulpwood and sawlog markets separately.  Cointegration test results offer limited support for the Law of One Price in the South for both products.  Results of the meta-analytic regressions show that a proxy for the cost of product transfer between regions is statistically significant and negatively related to the probability that two local market prices are cointegrated for only sawlogs.  For pulpwood, the proxy was not significant.  The results of the bivariate cointegration tests and the multivariate meta-analyses were used to delineate apparently spatially segmented sub-markets for both products.  The maps show overlapping geographical segments, resulting from both spatial arbitrage and possible output dominance for certain firms in those sub-markets.  The southern pine sawlog market can be divided into four or five sub-markets, distributed north to south and east to west.  The southern pine pulpwood log market can be drawn into three, largely separate sub-markets:  a coastal zone that stretches from Texas to Virginia, and two distinct interior zones.

Cubbage, F. W., A. Snider, et al. (2003). Chapter 3:  private forests:  management and policy in a market economy. Forests in a market economy. E. Sills and K. L. Abt. Dordrecht, Netherlands, Kluwer Academic Publishers: 23-38.

Das, G. and J. Alavalapti (2003). "Trade-mediated biotechnology transfer and its effective absorption:  an application to the U.S. forestry sector." Technological Forecasting and Social Change:  An International Journal 70: 545-562.

In this paper, we analyze the consequences of biotechnology innovations in the United States forest sector (logging) by modeling technology transfer embodied in trade flows and its absorption.  A seven-region, seven-traded-commodity version of a dynamic computable general equilibrium model is used to achieve this task.  A 0.63% Hicks-neutral biotechnological progress in the source region (U.S.) has differential impacts on the productivity of the log-using sectors in the domestic as well as in the recipient regions.  Since recipient regions' ability to utilize biotechnology innovations depends on their absorptive capacity (AC) and structural similarity (SS), we construct the AC and SS indices based on multiplicity of factors such as human capital endowments, skill content and social appropriateness of the new innovations.  The model results show that biotechnological innovations in the U.S. forest sector result in a significant increase in timber production.  Following the productivity improvements and its embodied spillover, wood products and pulp and paper sectors in the U.S. register higher productivity growth.  The role of AC and SS in capturing technical change is shown to be evident.  In the face of growing regulations on timber production from public forests, increasing productivity through biotechnology may be the most effective way to meet the consumer demand for forest products

Luppold, W. G. and J. P. Prestemon (2003). "Are prices of hardwood lumber interrelated or independent?" Forest Science 49(6).

Hardwood lumber prices are unique because of the large number of marketable species and variability of prices across species.  Previous research showed  that long run fashion decisions regarding species

selection may be influenced by price, so the interaction between fashion and species price may act to keep prices (hence, demand) of different hardwood species together in the long run. To test this hypothesis, we examined the joint lumber price behavior of six major hardwood species representing different appearance characteristics in the Appalachian hardwood region. Bivariate and multivariate price cointegration tests within lumber grades of these mainly nonstationary price series, conducted using a consistent vector error-correction rank and lag order model selection procedure, revealed no stable long run statistical relationships, rejecting the principal null hypothesis. Current relative price levels therefore cannot be used to infer future relative levels. Supplementary vector autoregressions of mostly differenced series, however, indicate that some interspecies price relationships exist. Such relationships, however, were mostly confined within appearance groups and only rarely across groups.

Mercer, D. E. and S. Pattanayak (2003). Chapter 16: agroforestry adoption by smallholders. Forests in a market economy. E. Sills and K. L. Abt. Dordrecht, Netherlands, Kluwer Academic Publishers: 283-299.

Murray, B. C. and J. P. Prestemon (2003). Chapter 10: structure and efficiency of timber markets. Forests in a market economy. E. Sills and K. L. Abt. Dordrecht, Netherlands, Kluwer Academic Publisher: 153-176.

Nagubadi, R. V., R. D. Fight, et al. (2003). Valuing a log: alternative approaches. Portland, OR, U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station: Research Note PNW-541. 15pp.

The gross value of products that can be manufactured from a tree is the starting point for a residual-value appraisal of a forest operation involving the harvest of trees suitable for making forest products. The amount of detail in a model of gross product value will affect the statistical properties of the estimate and the amount of ancillary information that is provided. Seven data sets from forest product recovery studies of western conifers were used in the evaluation of three models of gross product value. The evaluation of these models was based on the need for information and the statistical properties of the estimators. The most detailed method provide additional information, but at some loss in the precision and accuracy of the prediction of gross value of products from a log

Nagubadi, V. and D. Zhang (2003). Species substitution in softwood lumber consumption in the US: preliminary results. Proceedings of the 2002 Southern Forest Economics Workshop, Virginia Beach, VA, Virginia Polytechnic Institute and State University.

This study addresses an important dimension concerning the softwood lumber dispute between U.S. and Canada. While U.S. lumber producers argue that the softwood lumber species are substitutes, U.S. consumer groups and Canadian lumber industry point out that the softwood lumber imports from Canada and softwood lumber production in U.S. are highly complementary. We employ the translog restricted cost function approach to study this issue based on the monthly data of U.S. softwood lumber consumption and prices for the period from January 1989 to July 2001. The results reveal that the main imported Canadian lumber species group--spruce-pine-fir-- is largely unrelated to the domestically produced treated southern yellow pine, Douglas-fir, and other species groups, but is a substitute only to untreated southern yellow pine and engineered wood products. Furthermore, untreated southern yellow pine is facing more severe competition from engineered wood products rather than from imported Canadian spruce-pine-fir group.

Pattanayak, S. K., D. E. Mercer, et al. (2003). "Taking stock of agroforestry adoption studies." Agroforestry Systems 57: 173-186.

In light of the large number of empirical studies of agroforestry adoption published during the last decade, we believe it is time to take stock and identify general determinants of agroforestry adoption. In reviewing 120 articles on adoption of agricultural and forestry technology by small holders, we find five categories of factors that explain technology adoption within an economic framework: *preferences, resource endowments, market incentives, biophysical factors,* and *risk and uncertainty.* By selecting only empirical analyses that focus on agroforestry and related investments, we narrow our list down to 32 studies primarily from tropical areas. We apply vote-counting based meta-analysis to these studies and evaluate the inclusion and significance of the five

adoption factors. Our analysis shows that preferences and resource endowments are the factors most often included in studies. However, adoption behavior is most likely to be significantly influenced by risk, biophysical, and resource factors. In our conclusion, we discuss specific recommendations for the next generation of adoption studies and meta-analyses that include considering a fuller menu of variables, reporting key statistics and marginal probabilities and conducting weighted meta-regressions.

Prestemon, J. P. (2003). "Evaluation of U.S. southern pine stumpage market informational efficiency." Canadian Journal of Forest Research 33(4): 561-572.

The literature on informational efficiency of southern timber markets conflicts. Part of this conflict is because of differences in how efficiency was tested. In this paper, price behavior tests are based on deflated ("real") southern pine (*Pinus* spp.) sawtimber stumpage prices, using some of the same data and tests used in previous research and some new data and tests. Here, different results are found in many cases regarding price behavior, as compared with the existing literature. Using a valid and consistent data-based model selection procedure, augmented Dickey-Fuller tests cannot reject a null of a unit root for most deflated monthly and all quarterly southern pine timber price series evaluated. Regressions of long-term deflated timber price ratios on their own lags lead to results similar to those offered by other authors when not corrected for bias but produce fewer similarities when bias is addressed. The results of those regressions support a contention that most of the monthly series contain nonstationary as well as stationary components and that quarterly prices tested in this framework using data through 2001 are closer to pure nonstationary processes. These results have implications for harvest timing approaches that depend on serial dependence of timber prices, provide support for certain kinds of policy and catastrophic shocks modeling procedures, and address the validity of statistical approaches best suited to evaluating interconnections among timber markets

Prestemon, J. P., J. M. Pye, et al. (2004). "Temporal aggregation and testing for timber price behavior." Natural Resource Modeling 17(1).

Different harvest timing models make different assumptions about timber price behavior. Those seeking to optimize harvest timing are thus first faced with a decision regarding which assumption of price behavior is appropriate for their market, particularly regarding the presence of a unit root in the timber price time series. Unfortunately for landowners and investors, the literature provides conflicting guidance on this subject. One source for the ambiguous results of unit root tests of timber prices may involve data problems. We used Monte Carlo simulations to show that aggregating observations below their observed rate resulted in similar power reductions and empirical size distortions across three classes of unit root tests. Moving-average error structures can also affect power and sizes of tests on period-averaged data. Such error structures can also be created by the kind of temporal averaging common in reported timber prices. If we take timber prices at their face value and therefore ignore these sampling error and temporal aggregation complications, we find that unit root tests on southern timber prices support a unit root in 158 out of 208 product-deflation combinations tested, random walks in 38 of the series found to be nonstationary, and stationarity in none. However, if we recognize temporal aggregation errors, unit root tests more commonly favor stationarity, especially for pulpwood stumpage. Because price trends for sawtimber and pulpwood products may behave differently even in the same region, stochastic harvest timing models must be developed that allow their multiple products to follow different price paths.

Rogers, W. R. and I. Munn (2003). "Forest management intensity: a comparison of timber investment management organizations and industrial landowners in Mississippi." Southern Journal of Applied Forestry 27(2): 83-91.

All timberland investment management organizations (TIMOs) and industrial landowners in Mississippi were surveyed during 1998-1999 to determine their annual forest management practices and related expenditures. The response rate was 65% and respondents accounted for approximately 90% of the timberland owned by these two landowner groups. For analysis purposes, industrial landowners were separated into two categories: large (> 10,000 ac) and small (< 10,000 ac). Pine plantations represented 66% of TIMOs' timberland base compared to 55% for large industrial landowners and less than 50% for small industrial landowners. Over the two-year study period, TIMOs and large industrial landowners invested heavily in site preparation and planting as well as mid-rotation chemical release and fertilization. In contrast, small industrial

landowners relied on natural regeneration to a much greater extent and conducted few, if any, mid-rotation treatments.  As a group, TIMOs and industrial landowners spent approximately $20/ac annually on their Mississippi timberlands.  Overhead represented slightly over 40% of this total with silvicultural treatments accounting for the remainder.  Property taxes represented the largest overhead expense.  In total, these landowners spent $67 million in 1998 and $54 million in 1999 to maintain and manage their Mississippi timberlands

Vokoun, M. M. and G. S. Amacher (2003). Non-industrial landowners, the incentive to forego harvesting, and the importance of scale of activities. Proceedings of the 2002 Southern Forest Economics Workshop, Virginia Beach, VA, Virginia Polytechnic Institute and State University.

Despite all that has been written regarding NIPF landowners, there have not been any studies providing a clear examination of willingness to harvest using a range of harvesting prices.  An interesting problem that has not been previously examined is the determination of the relationship between the decision to harvest and a combination of characteristics of owners and their land, such as preferences, landowner type (absentee vs. resident), site qualities, that function in determining potential scale of harvesting activities.  This study examines which of these characteristics are important in landowner decisions regarding timber harvesting.  Landowner access to land and preferences regarding land use are important in the decision to forego harvesting, as well in determining the potential scale of harvesting activities

Wear, D. N. and S. Pattanayak (2003). Chapter 8:  aggregate timber supply:  from the forest to the market. Forests in a market economy. E. Sills and K. L. Abt. Dordrecht, Netherlands, Kluwer Academic Publishers: 117-132.

## in press    (2)

Nagubadi, V., D. Zhang, et al. (in press). "Softwood lumber products in the United States: substitutes or complements?" Forest Science.

This study addresses an important dimension concerning the softwood lumber trade dispute between U.S. and Canada-substitutability among imported and domestically produced species. We employ the restricted translog subcost function approach to study this issue based on the monthly data of U.S. softwood products consumption and prices between January1989 and July 2001. The results show that the spruce-pine-fir lumber species group, mainly imported from Canada, is largely unrelated to domestically produced treated southern yellow pine, Douglas-fir, and other species groups, but is a substitute to untreated southern yellow pine and engineered wood products. Furthermore, untreated southern yellow pine is facing more severe competition from structural panels rather than from the imported Canadian spruce-pine-fir group.

Wear, D. N. and B. C. Murray (in press). "Federal timber restrictions, interregional spillovers, and the impact on U.S. softwood markets." Journal of Environmental Economics and Management.

An econometric model of the US softwood lumber and timber markets is estimated and used to simulate the price, trade, and welfare effects of reductions in federal timber sales in the western US commencing in the late 1980s. Results indicate that the timber sale reductions increased lumber prices by roughly 15 percent in the mid-1990s. Lumber consumers were the unambiguous losers from the policy, while lumber and timber producers were net welfare gainers as the quantity-induced losses to western lumber producers were more than offset by price increases and quantity gains to southern US and Canadian lumber producers and timber producers in all regions.

# Spatial Assessment of Change in the South's Forests

## 1998 (2)

Wear, D. N. and P. Bolstad (1998). "Land-use changes in Southern Appalachian landscapes: spatial analysis and forecast evaluation." <u>Ecosystems</u> 1: 575-594.

Understanding human disturbance regimes is crucial for developing effective conservation and ecosystem management plans and for targeting ecological research to areas that define scarce ecosystem services. We evaluate and develop a forecasting model for land-use change in the Southern Appalachians. We extend previous efforts by (a) addressing the spatial diffusion of human populations, approximated by building density, (b) examining a long time period (40 years, which is epochal in economic terms), and (c) explicitly testing the forecasting power of the models. The resulting model, defined by linking a negative binomial regression model of building density with a logit model of land cover, was fit using spatially referenced data from four study sites in the Southern Appalachians. All fitted equations were significant, and coefficient estimates indicated that topographic features as well as location significantly shape population diffusion and land use across these landscapes. This is especially evident in the study sites that have experienced development pressure over the last 40 years. Model estimates also indicate significant spatial autocorrelation in land-use observations. Forecast performance of the models was evaluated by using a separate validation data set for each study area. Depending on the land-use classification scheme, the models correctly predicted between 68% and 89% of observed land uses. Tests based on information theory reject the hypothesis that the models have no explanatory power, and measures of entropy and information gain indicate that the estimated models explain between 47% and 66% of uncertainty regarding land-use classification. Overall, these results indicate that modeling land-cover change alone may not be useful over the long run, because changing land cover reflects the outcomes of more than one human process (for example, agricultural decline and population growth). Here, additional information was gained by addressing the spatial spread of human populations. Furthermore, coarse-scale measures of the human drivers of landscape change (for example, population growth measured at the county level) appear to be poor predictors of changes realized at finer scales. Simulations demonstrate how this type of approach might be used to target scarce resources for conservation and research efforts into ecosystem effects.

Wu, C.-T. (1998). Generalized estimating equations for spatially correlated data. Thesis, Department of Statistics, North Carolina State University: 197 pp.

Moment methods for analyzing longitudinal data have been proposed by Liang & Zeger (1986), extended by Prentice (1988), and adapted to spatially correlated binary data by Albert & McShane (1995). In their estimating equations, these authors estimate both the parameters for the mean model and the spatial correlation parameter. The estimating equations for the correlation parameter, which we call GEEla, use cross products of residuals (Albert & McShane, 1995). The variogram is a measure of spatial association in the class of intrinsically stationary spatial processes, which contains the class of second-order and weakly stationary processes. Based on the idea of the semivariogram, we propose a set of estimating equations that use squared differences of residuals, which we call GEElb.

## 1999 (2)

Munn, I. A. and D. Cleaves (1999). An analysis of losses to the southern commercial timberland base. <u>Proceedings of the 1998 Southern Forest Economics Workshop</u>, Research Triangle Park, NC, Southern Research Station.

Demographic and physical factors influencing the conversion of commercial timberland in the south to non-forestry uses between the last two Forest Inventory Analysis (FIA) surveys were investigated. GIS techniques linked Census data and FIA plot level data. Multinomial logit regression identified factors associated with losses to the timberland base. Conversion to agricultural uses represented the largest loss (1.48%) to the commercial timberland base. Slope, forest size, distance to the nearest city, as well as median income and education level were all negatively related to the probability a plot would be converted from forestry to agricultural uses.

Conversion to urban uses (1.13%) represented the second largest loss. Forest size, distance to developed areas and distance to the nearest city were all negatively related to the probability a plot would be converted to urban uses. Conversions to a number of miscellaneous uses accounted for an additional 0.38% loss.

Wear, D. N., J. M. Foreman, et al. (1999). "The effects of population growth on timber management and inventories in Virginia." Forest Ecology and Management 118: 107-115.

Expanding human populations may have important effects on the availability of timber from private lands in the South. To examine the effects of development on timber supply, the authors compared the density of populations and various site variables with expert opinions on the future location of commercial timberland for a study site in Virginia. Population density is a significant predictor of commercial timberland and resulting probability equations provide a method for adjusting timber inventories. Findings indicate that the transition between rural and urban land use occurs where population density is between 20 and 70 people per square mile. Population effects reduce commercial inventories between 30 and 49 percent in the study area.

# 2000 (6)

Cubbage, F. W., J. M. Pye, et al. (2000). "An economic evaluation of fusiform rust protection research." Southern Journal of Applied Forestry 24(2): 77-85.

Fusiform rust is a widespread and damaging disease of loblolly pine (P. taeda) and slash pine (P. elliottii) in the South. Research has identified families of these pines with improved genetic resistance to the disease, allowing production and planting of resistant seedlings in areas at risk. This study compared the cost of fusiform rust research to the simulated benefits of rust resistant seedlings in plantations that have been or are projected to be established Southwide between 1970 and 2020. Results showed that compounded fusiform rust research costs of $49 million in 1992 will return discounted benefits to plantation owners of between $108 and $999 million in 1992, at a 4% real discount rate. The most probable targeting of rust resistant seedlings would provide estimated discounted benefits of fusiform rust protection of about $200 to $300 million in 1992, or annual discounted benefits of $40 to $60 million. This would generate benefit-cost ratios of about 4:1 to 6:1 for fusiform rust research. Currently anticipated improvements in resistance will not eliminate all physical and financial damages from the disease; simulation results indicate substantial financial benefits yet remain for additional research and development.

Gumpertz, M. L., C.-T. Wu, et al. (2000). "Logistic regression for southern pine beetle outbreaks with spatial and temporal autocorrelation." Forest Science 46(1): 95-107.

Regional outbreaks of southern pine beetle (Dendroctonus frontalis Zimm.) show marked spatial and temporal patterns. While these patterns are of interest in themselves, we focus on statistical methods for estimating the effects of underlying environmental factors in the presence of spatial and temporal autocorrelation. The most comprehensive available information on outbreaks consists of binary data, specifically annual presence or absence of outbreak for individual counties within the southern United States. We demonstrate a method for modeling spatially correlated proportions, such as the proportion of years that a county experiences outbreak, based on annual outbreak presence or absence data for counties in three states (NC, SC, and GA) over 31 years. In this method the proportion of years in outbreak is predicted using a marginal logistic regression model with spatial autocorrelation among counties, with adjustment of variance terms to account for temporal autocorrelation. This type of model describes the probability of outbreak as a function of explanatory variables such as host availability, physiography, climate, hurricane incidence, and management type. Explicitly including spatial autocorrelation in the model yields improved estimates of the probability of outbreak for a particular county and of the importance of the various explanatory variables than would otherwise be obtained.

Hardie, I., P. Parks, et al. (2000). "Responsiveness of rural and urban land uses to land rent determinants in the U.S. South." Land Economics 76(4): 659-673.

Ricardian and von Thünen land rent models are combined into a single land use share model including farm, forest, and urban land uses. The land share model is applied to the Southern United States, and elasticities are extracted that measure land share response to changes in population,

income, land values, prices, and costs in counties with different degrees of urbanization. The study explores the effect of treating either rural or urban land as a residual use. While this practice is common in existing land use studies, it is found to significantly affect parameter estimates in this county-level analysis.

Mercer, E. and P. B. Aruna (2000). "Assessing the impacts of forests on human welfare: preliminary results from the Mid-Atlantic Integrated Assessment." Environmental Monitoring and Assessment 63: 43-63.

This paper presents results from the first phase of the socio-economic assessment of forest ecosystems in the Mid-Atlantic Integrated Assessment (MAIA). First, we present results of the analysis of changes in the distribution of human population and forest land use in the region. Then, trends in wood products employment and income between 1975-95 are used to examine the economic contributions of forest-based industries in the Mid-Atlantic region. Between 1970-90 the population of the MAIA region increased by 14% (4.3 million people) resulting in the average population density increasing by 25 people per square mile from 179 to 204 people per square mile. Nevertheless, population density was lower in large parts of the region in 1990 than in 1950. Although forests dominate the MAIA landscape, the trend is toward more people owning smaller forest land holdings, with developed lands increasing by 21% and rural lands decreasing by 2.64% between 1982-94. All ofthis suggests increasing forest fragmentation in all states of the region except New York, Pennsylvania, and West Virginia. Forest industry has been an important contributor to the economy of the MAIAregion, producing an average of a quarter million jobs (2.03% of all wage employment) and generating $4.5 billion in wages and salaries each year between 1975-95. If recent trends continue, forest industry will continue to be an important source of employment and income for parts of some states in the MAIA region; however, the forest industry's importance relative to the entire mid-Atlantic economy will likely continue to decline in the 21st century.

Prestemon, J. P. and T. P. Holmes (2000). "Timber price dynamics following a natural catastrophe." American Journal of Agricultural Economics 82: 145-160.

Catastrophic shocks to existing stocks of a renewable resource can cause long-run price shifts. With timber, these long-run price shifts may be accompanied by a short-run price drop due to salvage. Hurricane Hugo damaged 20% of southern pine timber in the South Carolina Coastal Plain in 1989. To estimate the short and long run effects of the hurricane on the prices of timber stocks, we estimated an intervention model of the residuals of cointegration of South Carolina sawtimber and pulpwood stumpage prices with prices of similar products from other regions. Modeling revealed a 30% negative price spike due to salvage and a long-run enhancement effect, leading to prices that are 10 to 30% higher than they would have been had Hugo not occurred.

Prestemon, J. P., J. M. Pye, et al. (2000). Market definition for hardwood timber in the Southern Appalachians. Proceedings of the 1999 Southern Forest Economics Workshop, Starkville, MS, Mississippi State University.

Direct estimation of aggregate hardwood supply is seriously complicated by the diversity of prices, species, and site conditions in hardwood stands. An alternative approach is to aggregate regional supply based on stumpage values of individual stands, arguably the real driver of harvest decisions. Complicating this approach is that species-specific prices are only available for logs delivered to the mill. To derive stumpage values, delivered prices must be reduced by the costs of harvesting and transport to the mill; hence, the spatial characteristics of the market may be important in defining the aggregate timber supply responsiveness to price. This paper represents an intermediate step in estimating an aggregate supply model for hardwood timber, where we tested the more limited hypothesis that harvest probability and hence stand age is positively related to timber value and negatively related to factors which reduce timber value. We regressed stand age on distances to three types of mills, slope of site, distance from the stand to the nearest road, site quality, and broad management type. We found that stand age increases with distance from mills for NIPF-, industry-, and government-managed stands in the Southern Appalachians. Stand age is negatively related to site quality, positively related to slope of stand, and not significantly affected by distance from the stand to the nearest road. Stand ages also vary by broad management type.

## 2001 (4)

Clark, J. S., S. R. Carpenter, et al. (2001). "Ecological forecasts: an emerging imperative." Science 293(5530): 657-660.

> Planning and decision-making can be improved by access to reliable forecasts of ecosystem state, ecosystem services, and natural capital. Availability of new data sets, together with progress in computation and statistics, will increase our ability to forecast ecosystem change. An agenda that would lead toward a capacity to produce, evaluate, and communicate forecasts of critical ecosystem services requires a process that engages scientists and decision-makers. Interdisciplinary linkages are necessary because of the climate and societal controls on ecosystems, the feedbacks involving social change, and the decision-making relevance of forecasts.

Murray, B. C., R. C. Abt, et al. (2001). "Land allocation in the Southeastern U.S. in response to climate change impacts on forestry and agriculture." World Resource Review 13(2): 239-251.

> Forest and agriculture are the two dominant land uses in the Southeastern U.S., collectively accounting for almost 90 percent of the land base. Differences in climate change impacts on forest and agricultural productivity can lead to reallocations of land between the two sectors as landowners adjust to the changes in economic conditions. In this paper, we apply the impacts of climate-induced changes in forest and agricultural economic rents to a model of land allocation for the Southeastern U.S. Climate change impacts on land use are evaluated relative to the demographic and commodity market factors that will affect future land uses independent of climate change.

Westerling, A. L., A. Gershunov, et al. (2001). Statistical forecasts of Western wildfire season severity. Proceedings of the 4th Symposium on Fire and Forest Meteorology, Reno, NV, American Meteorological Society, Boston, MA.

Wu, C.-T., M. L. Gumpertz, et al. (2001). "Comparison of GEE, MINQUE, ML, and REML estimating equations for normally distributed data." The American Statistician 55(2): 125-130.

> Generalized estimating equations (GEE) provide a regression framework for analyzing correlated data that are not necessarily assumed to be normal. For linear mixed models assuming normality, maximum likelihood (ML) and restricted maximum likelihood (REML) are commonly used for estimating variance and covariance parameters. In the analysis of variance tradition, minimum norm quadratic unbiased estimation (MINQUE) has been developed to estimate variance and covariance components without relying on distributional assumptions. This article rewrites the ML, REML, and MINQUE estimating equations in a form similar to GEE. This form is not particularly useful for computations, but it provides a very clear picture of the similarities and differences of the four methods. The derivations are straightforward and suitable for a linear models course.

## 2002 (4)

Munn, I. A., S. A. Barlow, et al. (2002). "Urbanization's impact on timber harvesting in the South-Central United States." Journal of Environmental Management 64(1): 65-76.

> The impact of urbanization on timber harvesting in the south central United States was investigated. Geo-referenced Census and Forest Inventory Analysis (FIA) data were combined using a geographic information system (GIS) in order to examine the effects of various demographic and biophysical forest inventory characteristics on timber harvesting. These effects were estimated for intermediate and final harvests using a multinomial logit model. The probability for both types of harvests decreased with increasing population density, decreasing forest size, and decreasing distance to urban areas; however, the reduction in intermediate harvests was greater for each variable. Harvesting rates decreased by as much as 19% as population densities increased or distance to urban areas decreased. The results indicated that active forest management is curtailed far beyond the urban boundary. In order to model the impact of urbanization adequately, timber supply projections must also account for its impact on harvesting frequencies in surrounding areas.

Prestemon, J., J. M. Pye, et al. (2002). "Understanding broadscale wildfire risks in a human-dominated landscape." Forest Science 48(4): 685-693.

Broadscale statistical evaluations of wildfire incidence can answer policy-relevant questions about the effectiveness of microlevel vegetation management and can identify subjects needing further study. A dynamic time series cross-sectional model was used to evaluate the statistical links between forest wildfire and vegetation management, human land use, and climatic factors in Florida counties. Four forest wildfire risk functions were estimated: one for fires regardless of ignition source, and three others for fires of specific ignition sources: arson, lightning, and accident (unintentional anthropogenic). Results suggest that current wildfire risk is negatively related to several years of past wildfire and very recent site prep burning, and risk is positively related to pulpwood removals. The effect of traditional prescribed burning on wildfire risk varies by ignition source. El Nino-Southern Oscillation (ENSO) sea surface temperature (SST) anomalies were also significantly linked to forest wildfire risk, but a measure of the wildland-urban interface was not significant. Although these county-level results hold promise for aggregate risk assessment, modeling at finer spatial and temporal scales might further enhance our understanding of how land managers can best reduce the longer term risk of catastrophic wildfire damages. For. Sci. 48(4):685-693

Westerling, A. J., A. Gershunov, et al. (2002). "Long lead statistical forecasts of area burned in western U.S. wildfires by ecosystem province." International Journal of Wildland Fire 11: 257-266.

A statistical forecast methodology exploits large-scale patterns in monthly U.S. Climatological Division Palmer Drought Severity Index (PDSI) values over a wide region and several seasons to predict area burned in western U.S. wildfires by ecosystem province a season in advance. The forecast model, which is based on canonical correlations, indicates that a few characteristic patterns determine predicted wildfire season area burned. Strong negative associations between anomalous soil moisture (inferred from PDSI) immediately prior to the fire season and area burned dominate in most higher elevation forested provinces, while strong positive associations between anomalous soil moisture a year prior to the fire season and area burned dominate in desert and shrub and grassland provinces. In much of the western U.S., above- and below-normal fire season forecasts were successful 57% of the time or better, as compared with a 33% skill for a random guess, and with a low probability of being surprised by a fire season at the opposite extreme of that forecast

Wu, C.-T. and M. L. Gumpertz (2002). "GEE1a1b brief manual." North Carolina State University, Institute of Statistics Mimeo Series(2514): 1-14.

# 2003 (4)

Hardie, I. W., P. J. Parks, et al. (2003). Responsiveness of rural and urban land uses to land rent determinants in the South. The Economics of Land Use. P. J. Parks and I. W. Hardie. Hampshire, England, Ashgate Publishing Ltd.

Holmes, T. P., J. P. Prestemon, et al. (2003). Using size-frequency distributions to analyze fire regimes in Florida. Fire in temperate, boreal and montane ecosystems, Proceedings of the Tall Timbers 22nd Fire Ecology Conference, Kananaskis Village, Alberta, Canada, Tall Timbers Research Station and the Canadian Forest Service.

Wildfire regimes in natural forest ecosystems have been characterized with power-law distributions. In this paper, we evaluated whether wildfire regimes in a human-dominated landscape were also consistent with power-law distributions. Our case study focused on wildfires in Florida, a state with rapid population growth and consequent rapid alteration of forest ecosystems and natural fire regimes. We found that all fire size-frequency distributions evaluated in this study were consistent with power-law distributions, but the power-law distributions were piece-wise linear. A kink in the power-law distributions occurred at about 640 ha for flatwoods fires and at about 290 ha for swamp fires. Above these levels, fires "exploded" into a catastrophic regime. If the kink represents the level at which fires become immune to fire suppression effort, we would expect that the location of the kink would occur at smaller fire sizes during extreme fire years due to the increased flammability of fuels and the relative scarcity of fire suppression resources. We found this result for 3 of 4 extreme fire years in flatwoods ecosystems and for all 4 extreme fire years in swamps. These results suggest that catastrophic fires may not be possible to prevent and that suppression efforts during extreme fire years may be best applied to strategic areas that decrease the connectivity of fuels.

Huggett, R. J. (2003). Fire in the wildland-urban interface: an examination of the effects of wildfire on residential property markets. Thesis, Raleigh, NC, North Carolina State University.

Housing markets near forests and wildland should capitalize into prices the value of forest amenities such as recreational opportunities, attractive scenery, and clean air. The expanding wildland-urban interface has made wildfire a frequently discussed and contentious public policy issue over the past decade. As residential communities expand into natural areas, more lives and property are placed at risk of death and destruction from wildfire. Housing markets are impacted by both the mere presence of fire risk as well as the damage to forest amentities and property that accompanies a wildfire. The purpose of this research is to empirically identify these responses. A data set comprised of residential housing sales from 1992-1996 in Chelan County, Washington was used to determine how the market responded to the 1994 fires in the Wenatchee National Forest that burned over 180,000 acres. The results indicate a decrease in the willingness to pay to live near the burned area for a six-month period in early 1995. There is no change in the willingness to pay to live near areas of relatively higher fire risk defined by higher fuel levels, which can be interpreted as a lack of support for collective protective measures that would reduce fuels. Additionally, the hedonic price for a fire-resistant roof increases gradually for 18 months before dropping to pre-fire levels in the second half of 1996. This result indicates that the subjective or perceived risk of property damage from wildfire behaved in a similar fashion and suggests either a risk threshold below which the household disegards the risk of fire or a general lack of awareness of risk.

Turner, M. G., S. M. Pearson, et al. (2003). "Effects of land-cover change on spatial pattern of forest communities in the Southern Appalachian Mountains (USA)." Landscape Ecology 18(5): 449-464.

Understanding the implications of past, present and future patterns of human land use for biodiversity and ecosystem function is increasingly important in landscape ecology. We examined effects of land-use change on four major forest communities of the Southern Appalachian Mountains (USA), and addressed two questions: (1) Are forest communities differentially susceptible to loss and fragmentation due to human land use? (2) Which forest communities are most likely to be affected by projected future land cover changes? In four study landscapes, maps of forest cover for four time periods (1950, 1970, 1990, and projections for 2030) were combined with maps of potential forest types to measure changes in the extent and spatial pattern of northern hardwoods, cove hardwoods, mixed hardwoods, and oak-pine. Overall, forest cover increased and forest fragmentation declined in all four study areas between 1950 and 1990. Among forest community types, cove hardwoods and oak-pine communities were most affected by land-cover change. Relative to its potential, cove hardwoods occupied only 30-40% of its potential area in two study landscapes in the 1950s, and oak-pine occupied ~50% of its potential area; cove hardwoods remained reduced in extent and number of patches in the 1990s. Changes in northern hardwoods, which are restricted to high elevations and occur in small patches, were minimal. Mixed hardwoods were the dominant and most highly connected forest community type, occupying between 47 and 70% of each study area. Projected land-cover changes suggest ongoing reforestation in less populated regions but declining forest cover in rapidly developing areas. Building density in forest habitats also increased during the study period and is projected to increase in the future; cove hardwoods and northern hardwoods may be particularly vulnerable. Although increases in forest cover will provide additional habitat for native species, increases in building density within forests may offset some of these gains. Species-rich cove hardwood communities are likely to be most vulnerable to future land-use change.

# Measures of Sustainability

## 1998 (1)

Pendleton, L., B. Sohngen, et al. (1998). "Measuring environmental quality in the Southern Appalachian Mountains." Forest Science 44(4): 603-609.

This study presents a method for valuing recreational environmental quality in the forests of the southeastern United States. The paper offers a method for choosing, measuring, and valuing forest attributes. Surveys and popular recreation literature are used to identify forest attributes that contribute to recreational quality. Standard ecological techniques are employed to measure levels of these attributes along trails in Tennessee, North Carolina, and Georgia. Finally, the paper demonstrates how hedonic methods can be used to assign values to forest attributes. We show that values for recreational quality vary across users and sites. Furthermore, we demonstrate the existence of negative marginal values for certain forest attributes and provide evidence that suggests these negative values are not the result of mis-specification, but are consistent with oversatiation.

## 1999 (3)

Abt, K. L., J. L. Greene, et al. (1999). Chapter 6 - Timber Resources [in Ozark-Ouachita Highlands Assessment Report 4 - Social and Economic Conditions]. Asheville, NC, USDA Forest Service, Southern Research Station.

The timber resource plays significant roles in the economy and culture of the Highlands. These roles have changed over the years in response to changes in the timber resource itself, in the market demand for wood products, and in societal values. For example, the harvest of large diameter pine sawtimber played a dominant role in the timber industry of the early years of this century. Today, the increasing role of small diameter hardwoods for export markets is the subject of much public controversy. This chapter describes the timber market through a discussion of the prices and production of various wood products and the factors that influence supply and demand. In addition, a model of timber supply provides projections of future inventory, growth, and harvest in the Highlands, within the context of the southwide timber markets for hardwoods and softwoods. (The term southwide as used here means including or affecting all the Southern States of the United States.)

Aldy, J. E., R. A. Kramer, et al. (1999). "Environmental equity and the conservation of unique ecosystems: an analysis of the distribution of benefits for protecting Southern Appalachian spruce-fir forests." Society and Natural Resources 12: 93-106.

Some critics in the environmental equity literature argue that low-income populations disproportionately have environmental risks, while the wealthy and better educated gain disproportionately from protecting unique ecosystems. The authors test this hypothesis in an analysis of the decline of Southern Appalachian spruce-fir forests. They calculate willingness-to-pay measures for forest protection through a contingent valuation survey. Survey respondents consider spruce-fir forest protection to be a normal good (income elasticity: 0.421). Education does not influence willingness-to-pay. In an assessment of willingness-to-pay scaled by income, the authors found that income has a negative effect, implying that as income increases, willingness-to-pay as a percentage of income decreases. Education weakly influences willingness-to-pay in this assessment. Given the substantial existence and bequest values associated with these forests, these results substantiate our rejection of the hypothesis that conserving this unique ecosystem only benefits the wealthy and better educated.

Busby, R. L., K. L. Abt, et al. (1999). Chapter 4 - Economic Profile [in Ozark-Ouachita Highlands Assessment Report 4 - Social and Economic Conditions]. Asheville, NC, USDA Forest Service, Southern Research Station.

This chapter begins with an analysis of the direct economic effects of the 10 principal industrial sectors that make up the economy of the Ozark-Ouachita Highlands. The forest products and minerals industries are analyzed in more detail than other industries because of their partial dependence on public lands (national forests in particular) for their supply of raw materials. In addition, the travel industries of Arkansas and Missouri are analyzed in detail because they include significant components of the tourism and outdoor recreation-based economy that are partially dependant on recreational opportunities provided on public lands. Equivalent travel data for Oklahoma were not available. The second section of this chapter focuses on the role that national forests play in the Assessment area's economy, specifically the economic effects of national forest timber harvesting, mining, recreation use, Forest Service expenditures, and "25 percent returns" to States. The analysis includes calculations of the secondary impacts or "ripple" effect in the economy of these programs and an estimate of the amount that national forest programs contribute to the Assessment area's Gross Regional Product (GRP).

# 2000 (1)

Wear, D. N. (2000). Forest land use changes: fragmentation, urbanization and population, Proceedings: Perspectives on Sustainable Forestry for the South. Raleigh, NC, The Southern Center for Sustainable Forests, North Carolina State University.

My objective today is to look at the sustainability issue from another angle. I'm going to look specifically at land use, how land has changed and how it may change in the future. Instead of talking about fragmentation specifically, I will be talking about urbanization that is driven by population growth, as well as the markets for timber and agricultural products...

# 2001 (1)

Moffat, S. O., F. W. Cubbage, et al. (2001). "Characterizing the sustainable forestry issue network in the United States." Forest Policy and Economics 2(3-4): 307-318.

Issue network analysis techniques were applied to the issue of sustainable forestry in the United States to identify potential public and private outcomes for the issue. A quantitative approach based on work by Laumann and Knoke [The Organizational State (1987)] was utilized in conjunction with the Delphi method. Results suggest that the parity in the distribution of influence among network sectors means that moving the issue of sustainable forestry onto the formal policy agenda will require more consensus on problems and solutions than exists at the present time. Accordingly, broad policy actions resulting from the expansion of the issue of sustainable forestry are unlikely in the short-term. However, experts on the Delphi panel anticipate that changes will occur in response to sustainability issues. At the federal and state level, this is likely to result in changes to public forest management and to the objectives assigned to the USDA Forest Service and to the state forestry agencies. States are projected to draft new and to change old private forest practices regulations as a result of sustainable forestry concerns. In the private sector, the trend of applying criteria and indicator-based sustainable forestry management standards and certification programs will continue. Non-industrial private forest owners are projected to make the fewest direct accommodations. Finally, where directly comparable, the Delphi study's results were not significantly different from the quantitative approach, suggesting that Delphi has promise for network research applications.

# 2002 (9)

Abt, K. L., S. A. Winter, et al. (2002). Chapter 10: local economic impacts of forests. Southern forest resource assessment. D. N. Wear and J. G. Greis. Asheville, NC, U.S. Department of Agriculture, Forest Service, Southern Research Station: Gen. Tech. Rpt. SRS-53:239-267.

The southern forest resource assessment provides a comprehensive analysis of the history, status, and likely future of forests in the Southern United States. Twenty-three chapters address questions regarding social/economic systems, terrestrial ecosystems, water and aquatic ecosystems, forest health, and timber management; 2 additional chapters provide a background on history and fire. Each chapter surveys pertinent literature and data, assesses conditions, identifies research needs, and examines the implications for southern forests and the benefits that they provide

Greis, J. G. and D. N. Wear (2002). "Conducting science in the public eye." <u>Journal of Forestry</u> 100(7): 46-49.

> Questions about the long-term sustainability of southern forest benefits, including wildlife habitat, water quality, and timber supply, prompted this regional assessment and guided the process by which it was conducted.  SFRA's final report is descriptive--not prescriptive--and is intended to inform debate and policymaking in technically defensible, unbiased, and understandable terms.  Although the analysis was science based and peer reviewed, the public helped frame the questions and critique the answers.  This article describes the process used to complete the assessment and draws out several general observations about conducting a scientific analysis of this scope in a public setting

Holmes, T. P. (2002). Chapter 12:  forests and the quality of life. <u>Southern Forest Resource Assessment</u>. D. N. Wear and J. G. Greis. Asheville, NC, U.S. Department of Agriculture, Forest Service, Southern Research Station: Gen. Tech. Rpt. SRS-53:283-295.

> The southern forest resource assessment provides a comprehensive analysis of the history, status, and likely future of forests in the Southern United States.  Twenty-three chapters address questions regarding social/economic systems, terrestrial ecosystems, water and aquatic ecosystems, forest health, and timber management; 2 additional chapters provide a background on history and fire.  Each chapter surveys pertinent literature and data, assesses conditions, identifies research needs, and examines the implications for southern forests and the benefits that they provide

Pattanayak, S. K. and D. E. Mercer (2002). "Indexing soil conservation: farmer perceptions of agroforestry benefits." <u>Journal of Sustainable Forestry</u> 15(2): 63-85.

> Soil erosion poses economic and environmental concerns in many tropical uplands. Agroforestry has been proposed as a sustainable land use that can mitigate soil erosion and promote the economic welfare of small farmers. To evaluate such claims, we must (a) develop a composite measure of effectiveness, such as a soil conservation index, and (b) define it in terms understood by the farmers who ultimately choose to adopt and implement agroforestry. We construct an empirical soil conservation index as a weighted average of farmer perceptions of four soil attributes and develop a statistical model of soil conservation benefits of agroforestry by using survey data from the Philippines. Accounting for self-selection bias, we evaluate the soil conservation benefits by testing the correlation between the index and the level of agroforestry adoption. Our estimated model shows that agroforestry can generate 15-20 percent soil conservation for the typical small famer. We offer several methodological, practical, and policy insights. Because many farmers in developing countries face informational and capital constraints, our study suggests that public policies should support small-holder agroforestry, a type of "natural investment" in soil capital, to generate private and public benefits.

Prestemon, J. P. and R. C. Abt (2002). Chapter 13:  timber products supply and demand. <u>Southern Forest Resource Assessment</u>. D. N. Wear and J. G. Greis. Asheville, NC, U.S. Department of Agriculture, Forest Service, Southern Research Station: Gen. Tech. Rpt. SRS-53:299-325.

> The southern forest resource assessment provides a comprehensive analysis of the history, status, and likely future of forests in the Southern United States.  Twenty-three chapters address questions regarding social/economic systems, terrestrial ecosystems, water and aquatic ecosystems, forest health, and timber management; 2 additional chapters provide a background on history and fire.  Each chapter surveys pertinent literature and data, assesses conditions, identifies research needs, and examines the implications for southern forests and the benefits that they provide

Wear, D. N. (2002). Chapter 6:  land use. <u>Southern forest resource assessment</u>. D. N. Wear and J. G. Greis. Asheville, NC, U.S. Department of Agriculture,  Forest Service, Southern Research Station: Gen. Tech. Rpt. SRS-53:153-173.

> The southern forest resource assessment provides a comprehensive analysis of the history, status, and likely future of forests in the Southern United States.  Twenty-three chapters address questions regarding social/economic systems, terrestrial ecosystems, water and aquatic ecosystems, forest health, and timber management; 2 additional chapters provide a background on history and fire.

Each chapter surveys pertinent literature and data, assesses conditions, identifies research needs, and examines the implications for southern forests and the benefits that they provide

Wear, D. N. and J. G. Greis eds. (2002). Southern forest resource assessment. Asheville, NC, U.S. Department of Agriculture, Forest Service, Southern Research Station: Gen. Tech. Rpt. SRS-53. 635 pp.

The southern forest resource assessment provides a comprehensive analysis of the history, status, and likely future of forests in the Southern United States.  Twenty-three chapters address questions regarding social/economic systems, terrestrial ecosystems, water and aquatic ecosystems, forest health, and timber management; 2 additional chapters provide a background on history and fire. Each chapter surveys pertinent literature and data, assesses conditions, identifies research needs, and examines the implications for southern forests and the benefits that they provide

Wear, D. N. and J. G. Greis (2002). "Southern forest resource assessment:  summary of findings." <u>Journal of Forestry</u> 100(7): 6-14.

The Southern Forest Resource Assessment (SFRA) was initiated in spring 1999 to address broad questions concerning the status, trends, and likely future of southern forests.  A descriptive assessment such as SFRA can be used to highlight the major dynamics and uncertainties at play within a region's forested ecosystems, thereby focusing public discourse.  Because SFRA has only recently been completed, however, it is too early to examine its effectiveness as a basis for debate and policy.  This summary describes live major forces of change affecting southern forests and then characterizes the trends in various forest conditions and their implications

Wear, D. N. and J. G. Greis (2002). The southern forest resource assessment:  summary report. Asheville, NC, U.S. Department of Agriculture, Forest Service, Southern Research Station: Gen. Tech. Rpt. SRS-54. 103 pp.

## 2003 (3)

Pattanayak, S. and D. T. Butry (2003). Chapter 20:  forest ecosystem services as production inputs. <u>Forests in a market economy</u>. E. Sills and K. L. Abt. Dordrecht, Netherlands, Kluwer Academic Publishers: 361-378.

Wear, D. N. (2003). Chapter 4:  large-scale regional assessments:  lessons learned from the Southern Appalachian Assessment. <u>Ecological Modeling for Resource Management</u>. V. H. Dale. New York, NY, Springer-Verlag: 70-85. Chapter 4.

Wear, D. N. and J. G. Greis (2003). "Assessing the South's forests." <u>Forest Landowner</u> 62(2): 27-29.

## In press    (1)

Wear, D. N. and J. G. Greis (in press). Lessons learned from the Southern Forest Resource Assessment. <u>Southern Forest Science: Past, Present and Future</u>. M. Rauscher, K. Johnsen and R. Doudrick.

The Southern Forest Resource Assessment (SFRA) was initiated in the spring of 1999 to address broad questions concerning the status, trends and possible future of southern forests. The overall objective of the Assessment was to develop a thorough and objective description of forest conditions and trends in the South, and to present it in a way that would help the public understand a complex and dynamic resource.  Findings of the Assessment highlight the forces of change at work in southern forests and potential ecological and economic implications.

# Understanding Values of Forest Goods and Services on Different Land Ownerships

## 1998 (1)

Pullis, G. (1998). Public perceptions of forest ecosystem attributes and economic values for small, private woodlots with and without alternative timber harvesting. Thesis, University of Maine. 138 pp.

> The public, represented by forest interest groups, is increasingly demanding a say in the management of private forest land. That the public is concerned with the health and conditions of private forest land is clear; what is unclear is how they perceive a healthy forest and how they value policies that promote forest health. Of equal importance is to what degree forest interest groups are truly representing the values and preferences of the general public.

## 1999 (6)

Boyle, K. J. and M. F. Teisl (1999). Public preferences for timber harvesting on private forest land purchased for public ownership in Maine. Orono, ME, Maine Agricultural and Forest Experiment Station, University of Maine. Miscellaneous Report 414. 18 pp.

Raunikar, R. and J. Buongiorno (1999). "[The role of economics in forest management: from Faustmann to the environmental Kuznets curve]." Revue Forestiere Francaise Numero Special: 102-116.

> [The Faustmann model embodies the application of fundamental economic principles to the choice of management methods and alternative land uses. The price of products is a key input in applications of this principle. For wood prices, forest sector models provide a link between forestry and the rest of the economy, and thus a means to predict wood prices consistent with expected demographic and economic growth. To include the price of non-wood forest outputs, Faustmann's principle needs to be expanded with modern benefit-cost analysis. Evaluation of forest amenities in the absence of markets poses conceptual challenges and requires special analytical techniques such as contingent valuation. New valuation and demand forecasting methods based on macro-economic growth theory attempt to link the demand for environmental goods, such as forest diversity, to total aggregate consumption. These models, founded on the environmental Kuznets curve hypothesis could provide a means to calculate the value of forest amenities and to predict their future demand.]

Reaves, D. W., R. A. Kramer, et al. (1999). "Does question format matter? Valuing an endangered species." Environmental and Resource Economics 14: 365-383.

> A three-way treatment design is used to compare contingent valuation response formats. Respondents are asked to value an endangered species (the red-cockaded woodpecker) and the restoration of its habitat following a natural disaster. For three question formats (open-ended, payment card, and double-bounded dichotomous choice), differences in survey response rates, item non-response rates, and protest bids are examined. Bootstrap techniques are used to compare means across formats and to explore differences in willingness to pay (WTP) distribution functions. Convergent validity is found in a comparison of mean WTP values, although some differences are apparent in the cumulative distribution functions. Differences across formats are also identified in item non-response rates and proportion of protest bids. Overall, the payment card format exhibits desirable properties relative to the other two formats.

Scarpa, R. (1999). Assessing the amenity value of forests, with applications to Wisconsin and Ireland, Thesis, University of Wisconsin, Madison WI.

> The objective of this research is the valuation of the amenity function of forests. In Wisconsin Northern hardwoods forests, the goals are (i) to develop a method to compute the amenity value (non-timber value) of uneven-aged forests; (ii) to determine how individual stand characteristics, and those of its owner, influence non-timber value; (iii) to apply the methods to the maple-birch

forest type. In Irish forest parks, the goals are (i) to estimate willingness to pay for recreation with stated and revealed-preference methods; (ii) to investigate the effects of forest attributes on these estimates, with particular regards to the effects of nature reserves and the practice of benefit transfer; and (iii) to compare estimates of recreation values obtained by different methods and correlate them with aesthetics indices. The proposed measure of non-timber value (NTV) for Wisconsin uneven-aged forests is the opportunity cost of timber revenue foregone. This is revealed by the actual harvest decisions of the owner, in contrast with the potential profit-maximizing decision. This concept is applied to Wisconsin plots of the USDA Forest Inventory. The actual revenues are computed for each plot, and subtracted from the profit-maximizing revenues predicted with the model of Lin and Buongiorno (1996), giving data on the magnitude and distribution of non-timber value throughout the state. Hedonic pricing is used to estimate the amenity value of different forest characteristics. In the Irish application, data from a large scale forest recreation survey are used to estimate models of stated willingness to pay for forest recreation from discrete choice contingent valuation. An estimated model is used to predict benefits from creation of nature reserves in forests currently without one. The reliability of benefit transfer from CV models is investigated. Benefit estimates from CV analyses are compared with analog estimates based on the travel cost method. In both sets of estimates the effect of forest attributes is investigated. Finally, welfare estimates are compared across methods and with alternative quality indices of aesthetic value. Benefit estimates are found to be congruent with economic theory and positively correlated. CV is found to produce benefit estimates often transferable between forests.

Schaberg, R. H., T. P. Holmes, et al. (1999). "Ascribing value to ecological process: an economic view of environmental change." <u>Forest Ecology and Management</u> 114: 329-338.

Decisions made by individual landowners and public land managers can have a significant impact on the rates of ecological change. Interdisciplinary cooperation is desirable if economists and ecologists are to correctly interpret the impacts of individual choices for landscape management. This paper reports results from two studies of the residents of North Carolina which contrast individual preferences for utilitarian forest benefits and financial returns with less tangible benefits of forest amenities and ecosystem stability. One study reports preliminary findings from a forest-benefit mail survey on the Nantahala and Pisgah National Forests; the second study presents an analysis of harvest decisions by private landowners. Economic methods pertinent to valuation of environmental goods are briefly considered. Individual behavior is described which suggests that segments of the public recognize welfare benefits specifically from forest amenities, and from "natural" production of environmental goods and services. The two studies suggest how economic tools may be extended to help quantify complex social and biological values associated with ecological processes.

Wear, D. N. (1999). "Challenges to interdisciplinary discourse." <u>Ecosystems</u> 2: 299-301.

Many of the world's critical problems involve human interactions with nature and their long-term implications for environmental quality and the sustainability of resource/ecological systems. These problems are complex--defined by the collective behaviors of people as well as by the structure and function of ecosystems--suggesting that both the social and the natural sciences should focus efforts on dimensions of these problems. The separate efforts of social and natural sciences are unlikely to fully illuminate the fabric of or fashion solutions to environmental problems. Rather, much might be gained by truly interdisciplinary research endeavors where each constituent discipline informs the investigation of the others and where hypotheses might even be jointly formed. Interdisciplinary research seems the best hope for unraveling the complex interactions between the collective behavior of Homo sapiens and their environment and yielding workable solutions to these problems.

# 2000 (5)

Ahn, S., J. E. de Steiguer, et al. (2000). "Economic analysis of the potential impact of climate change on recreational trout fishing in the Southern Appalachian Mountains: an application of a nested multinomial logit model." <u>Climate Change</u> 45: 493-509.

Global warming due to the enhanced greenhouse effect through human activities has become a major public policy issue in recent years. The present study focuses on the potential economic impact of climate change on recreational trout fishing in the Southern Appalachian Mountains of North Carolina. Significant reductions in trout habitat and/or populations are anticipated under

global warming since the study area is on the extreme margins of trout habitat of the eastern U.S. The purpose of this study is to estimate the potential welfare loss of trout anglers due to global warming. A nested multinomial logit model was developed and estimated to describe the angler's fishing choice behavior. The estimated median welfare loss (Compensating Variation) ranged from $5.63 to $53.18 per angler per single occasion under the various diminished trout habitat and/or population scenarios.

Conway, M. C., G. S. Amacher, et al. (2000). The effects of shifting preferences and forest fragmentation on nonindustrial forest landowner behavior: evidence from the South. Proceedings of the 1999 Southern Forest Economics Workshop, Starkville, MS, Mississippi State University.

The study was undertaken in response to a prediction by the Virginia Department of Forestry (VDOF) that current harvest levels cannot be sustained into the future given an increasing growth to removal insufficiency throughout the state of Virginia. The purpose of the study is to determine how market signals, land and owner characteristics, and owner preferences affect landowners' decisions concerning their forest land. Recent literature has focussed on the central determinants of harvesting and reforestation behavior. However, this study extends the literature by including bequest and debt decisions that are also essential in explaining the changing forest sector. Particular emphasis is placed on the effects of absenteeism and land fragmentation on landowner behavior. Such information in important for targeting policies that will successfully maintain commercial timber levels throughout the state.

Scarpa, R., J. Buongiorno, et al. (2000). "Assessing the non-timber value of forests: a revealed-preference, hedonic model." Journal of Forest Economics 6(2): 83-107.

Based on revealed preference theory, the value of non-timber goods and services obtained by forest owners, private or public, should be at least equal to the difference between the value of what they could have cut had they tried to maximize timber revenues, and of what they actually cut. This definition was applied to estimate the non-timber value (NTV) of Forest Inventory and Analysis plots in the Wisconsin maple-birch forest type, with a Markov decision model to predict the decision that would have maximized the timber income. Then hedonic regression was applied to determine how the biophysical characteristics of stands and the socioeconomic setting influenced NTV. In the Wisconsin maple-birch forests, the NTV was highest for national forests: about $50 ha-1yr-1, ten times the timber revenues. The estimated NTV was similar for all non-national forests, at about $20 to $24 ha-1yr-1. For non-national public forests, NTVs were four times larger than timber revenues. They were almost twice as large as timber revenues for private non-industrial forests. Even for industry forests, NTVs were slightly higher than timber revenues. However, these NTVs could be biased due to constraints limiting the potential economic return from forest stands not reflected by the profit-maximizing model. The hedonic pricing model showed that stands with the same tree distribution had significantly higher NTVs for national forests, and similar NTVs for other ownership types. The marginal value of trees of various species and size was also different for national forests. At constant prices, from 1966 to 1984, the non-timber value of maple-birch forests in Wisconsin increased by 30% for national forests, and 55% for other forests.

Scarpa, R., J. Buongiorno, et al. (2000). Determinants of non-timber values in Wisconsin northern hardwoods. Proceedings of the 1998 Southern Forest Economics Workshop: Part II, Research Triangle Park, NC, Southern Research Station.

A working definition of non-timber value is the difference between the revenues attainable by implementing an infinite horizon timber revenue maximizing cutting rule, and the value of the observed harvest. This non-timber value was estimated for the stands of the Forest Inventory Analysis data in the maple-beech-birch type in Wisconsin. Non-timber values averaged 23 $/ha/yr, and were higher than timber revenues, even on industry lands. Hedonic regression was then used to estimate the marginal effects on non-timber value of stand attributes and socio-economic variables. The results gave a vector of non-timber values for trees of different size and species. The marginal contributions of trees to non-timber values were significantly higher in National Forests.

Scarpa, R., S. M. Chilton, et al. (2000). "Valuing the recreational benefits from the creation of nature reserves in Irish forests." Ecological Economics 33: 237-250.

Data from a large-scale contingent valuation study are used to investigate the effects of forest attributes on willingness to pay for forest recreation in Ireland. In particular, the presence of a

nature reserve in the forest is found to significantly increase the visitors' willingness to pay. A random utility model is used to estimate the welfare change associated with the creation of nature reserves in all the Irish forests currently without one. The yearly impact on visitors' economic welfare of new nature reserves approaches half a million pounds per annum, exclusive of non-recreational values.

## 2001 (3)

Arano, K. G., T. L. Cushing, et al. (2001). Non-industrial private forest landowners' management expenditures in Mississippi, 1995-1997. Proceedings of the 2000 Southern Forest Economics Workshop, Monticello, Arkansas, School of Forest Resources, University of Arkansas.

A survey of non-industrial forest (NIPF) landowners in Mississippi was conducted to determine their annual expenditures on forest management practices for the period 1995-1997. The respondents were asked the amount they spent on property taxes, professional services, timber management activities and routine management activities. The average total expenditures were $2,827.03, $1,895.65 and $1,906.54 for 1995, 1996 and 1997, respectively. Expenditures by NIPF landowners did not differ significantly ( =0.05) over the three-year period. Property taxes averaged $530.14 annually over the survey period. Fees for professional services averaged $407.36 annually with consulting foresters representing the largest component of this category. Annual expenditures for timber management activities averaged $972.94 and routine management expenditures averaged $299.39. Site preparation and planting and road maintenance and construction were the largest components of these categories, respectively. Information was also solicited regarding government-related revenue and hunting-related expenditures and revenues. Results of the study indicate that variations in timber supply due to variations in management intensity by NIPF landowners over the study period are unlikely.

Pendleton, L. H. and J. S. Shonkwiler (2001). "Valuing bundled attributes: a latent characteristics approach." Land Economics 77(1): 118-129.

Lancaster wrote that attributes of goods may combine to produce characteristics that are the primary units of consumption (1966). Often, the attributes of goods are bundled and cannot be separated. We show that if attributes are technically bundled then valuation analyses that treat these attributes as independent will be wrong. We show that a latent characteristics approach improves upon other methods by incorporating more information about attributes than standard methods and by directly modeling the linkages among attributes. For the case of wilderness hiking, the latent approach provides a statistically better model of site choice than other standard methods

Raunikar, R. and J. Buongiorno (2001). Valuation of forest amenities: a macro approach. Proceedings of the 2000 Southern Forest Economics Workshop, Monticello, Arkansas, School of Forest Resources, University of Arkansas.

A method of estimating forest amenity value based on macroeconomic growth theory is presented. It relies on the assumption that more valuable forest amenities are provided by a forest with a more natural stand structure. We construct a forest naturalness index from stand data that provides a relative measure of the forest amenity provided regionally. This naturalness index is meant to assess the change in forest amenities over time. It is a measure of diversity within the allowable specimens (species/diameter height) of the natural forest type and observed successional stage. We aggregate the fraction of maximum diversity of the natural forest type for the target successional profiles of the natural forest types of the survey unit to calculate the index for the region. The paper shows a specific form for the path over which aggregate consumption, including forest market goods, and forest amenities, as measured by our naturalness index, evolve. This macroeconomic growth model assumes a trade-off between consumption growth and forest amenities. The present value of future consumption foregone by a marginal increase in the naturalness index is the shadow price of the forest amenity represented by the index increase. The value of any proposed forest policy change is the value of the index change that the new forest policy causes.

## 2002 (2)

Holmes, T., K. J. Boyle, et al. (2002). "A comparison of conjoint analysis response formats: reply." <u>American Agricultural Economics Association</u> 84(4): 1172-1175.

Smith, V. K. and S. Pattanayak (2002). "Is meta-analysis a Noah's ark for non-market valuation." <u>Environmental and Resource Economics</u> 22: 271-296.

> This paper describes meta-analytical methods as they have been applied to non-market valuation research. These studies have been used to review and synthesize literature and, more recently, in benefit transfer. This second use imposes a higher standard on the consistency in economic concepts being summarized and in the resources included in a meta-analysis. To meet this need, the paper proposes and illustrates a structural framework using a generalized method of moments estimator to estimate the parameters of a preference function with the benefits estimates usually encountered in meta-analytic summaries

## 2003 (8)

Buongiorno, J. and R. Raunikar (2003). Chapter 21: economics and the management of forests for wood and amenity values. <u>Introduction to Forest Ecosystem Science and Management</u>. R. A. Young and R. L. Giese. Hoboken, NJ, John Wiley & Sons, Inc.: 457-469.

Englin, J. E., T. P. Holmes, et al. (2003). Chapter 19: estimating forest recreation demand using count data models. <u>Forests in a market economy</u>. E. Sills and K. L. Abt. Dordrecht, Netherlands, Kluwer Academic Publishers: 341-359.

Englin, J., T. Holmes, et al. (2003). Alternative systems of semi-logarithmic incomplete demand equations : modeling recreational off-highway vehicle site demand. Proceedings of the 2003 W-133 Conference, Estimating Benefits and Costs in Natural Resource Management, Reno, NV.

> This study provides an empirical application of LaFrance's (1985, 1986, 1990) and von Haefen's (2002) approach to estimating a utility theoretic incomplete demand system. Two sets of utility theoretic restrictions are imposed on parameter sets estimated using Poisson and negative binomial II distributions. Data are provided by a survey conducted at four recreational off-highway vehicle (OHV) sites in western North Carolina. Results obtained under the two sets of restrictions are compared using a two-part likelihood ratio non-nested testing procedure and welfare measures are calculated for the ordinary and compensated demands. In the analyses reported here, welfare estimates varied dramatically dependent on the specification of the set of parameter restrictions. The implication of this analysis is that researchers should not naively apply parameter restrictions when estimating systems of semi-logarithmic incomplete demand equations, but should test alternative sets of utility theoretic restrictions to determine which set best conforms to the data.

Holmes, T. P. and K. J. Boyle (2003). Chapter 18: stated preference methods for valuation of forest attributes. <u>Forests in a market economy</u>. E. Sills and K. L. Abt. Dordrecht, Netherlands, Kluwer Academic Publishers: 321-340.

Kramer, R. A., T. P. Holmes, et al. (2003). Chapter 17: contingent valuation of forest ecosystem protection. <u>Forests in a market economy</u>. E. Sills and K. L. Abt. Dordrecht, Netherlands, Kluwer Academic Publishers: 303-320.

Pattanayak, S., K. L. Abt, et al. (2003). Chapter 14: timber and amenities on nonindustrial private forest land. <u>Forests in a market economy</u>. E. Sills and K. L. Abt. Dordrecht, Netherlands, Kluwer Academic Publishers: 243-258.

Raunikar, R. and J. Buongiorno (2003). <u>A macro approach to forest amenity valuation</u>. <u>Proceedings of the 2002 Southern Forest Economics Workshop</u>, Virginia Beach, VA, Virginia Polytechnic Institute and State University.

The environmental value of forests is an integral and increasing component of the total worth of forests. In this paper we describe empirical results and a simulation study of a macroeconomic forest environmental amenity valuation methods (Raunikar and Buongiorno, 2000). As an aggregate measure of regional forest naturalness we calculated diversity of natural tree types in the Forest Inventory and Analysis (FIA) survey units of the Southern United States. We demonstrate the behavior of our macroeconomic growth model in a simulation study using the economic history of the survey units in our study region and a hypothetical distribution of model parameters. We find that the value of natural forest amenities is distributed approximately log normal

Sills, E., S. Lele, et al. (2003). Chapter 15: nontimber forest products in the rural household economy. <u>Forests in a market economy</u>. E. Sills and K. L. Abt. Dordrecht, Netherlands, Kluwer Academic Publishers: 259-281.

## In press     (2)

Conway, M. C., G. S. Amacher, et al. (in press). "Decisions nonindustrial forest landowners make: an empirical examination." <u>Journal of Forest Economics</u>.

Our purpose is to estimate a model of non-industrial forest landowner behavior that considers certain types of behavior that have escaped discussion and rigorous investigation in the literature, yet which are critical to future policy making. Our focus on the many different but related decisions landowners make broadens the typical understanding of landowner behavior to show how bequest motives, debt and participation in non-market activities, and harvesting decisions, are interrelated and dependent on landowner preferences, market, and land characteristics.

Holmes, T. P. and W. L. Adamowicz (2003). Attribute-based methods. A Primer on Non-market Valuation. P. Champ, T. Brown and K. Boyle, Kluwer Academic Publishers.

# Forest Policy

## 1998 (3)

Alston, A. (1998). Effective community development: involving local residents in planning ecotourism in selected mountain communities of Jamaica. Thesis, North Carolina A&T State University. 93 pp.

Carter, D. R. and D. H. Newman (1998). "The impact of reserve prices in sealed bid federal timber sale auctions." Forest Science 44(4): 485-495.

> In this article we examine the impact of reserve prices on timber revenues from federal timber sale auctions in North Carolina from a game-theoretic perspective by recognizing the effect of competition on optimal bid strategies. The empirical model endogenizes the number of bidders in a simultaneous-equations Tobit framework, and estimates the impacts of the reserve price on the probability that an offering will sell, as well as on the sale price given that the offering is sold, in the presence of strategic bidding behavior. Model results support the underlying game-theoretic structure. The number of bidders and the reserve price are both important in determining market value or high bid. Using a Wu-Hausman test, we reject exogeneity in the number of bidders. Importantly, a calculation of the change in market value given a change in the reserve price shows that increasing reserve prices will likely increase timber revenues on sales in North Carolina, thus providing evidence that reserve prices are not optimal. However, increasing the reserve price will decrease the proportion of sold sales which may not support nontimber objectives of the Forest Service.

Moulton, R. J. (1998). "Tree Planting in the United States--1997." Tree Planters' Notes 49(1): 5-15.

> This annual report summarizes tree planting, timber stand improvement, and nursery production activities across all ownerships of forest land in the United States. It includes state-by-state and ownership breakdowns, regional totals, as well as analysis of the trends in the data. It does not include tree planting in urban and community environments. As far as we know, it is the most complete compilation of such data in the country. However, because some of the data are estimated, caution must be used in drawing inferences. 1997 SUMMARY: * Trees were planted on 2,636,102 acres. * Timber stand improvement was completed on 1,417,056 acres. * Nursery production totaled 1,623,978,000 trees.

## 1999 (8)

Boltz, F., T. P. Holmes, et al. (1999). The economics of reduced impact logging in the American tropics: a review of recent initiatives. Proceedings of the 1998 Southern Forest Economics Workshop, Research Triangle Park, NC, Southern Research Station.

> Programs aimed at developing and implementing reduced-impact logging (RIL) techniques are currently underway in important forest regions of Latin America, given the importance of timber production in the American tropics to national and global markets. RIL efforts focus upon planning and extraction methods which lessen harvest impact on residual commercial timber stocks, forest soils and vegetation, and ecological functions. Although the ecological benefit of RIL practices are widely acknowledged, forest management actions are commonly guided by policy constraints and economic decision-making which preclude the adoption of more conservative RIL practices. A review of forest management projects in Central and South America illustrates the ecological and economic benefits of RIL as well as constraints to greater adoption of RIL in forest management activities in the American tropics.

Donoghue, E. M. (1999). Community support organizations and community-based forest management in the Philippines. Thesis, NC State University. 209 pp.

> Community-based forest management is a strategy being adopted by many governments in developing countries. One objective is to enhance local control of, and benefits from, local resources. Another goal is to provide some form of management on national or state forestlands

and curb the destructive effects of an 'open access' system. By transferring responsibilities to the community group, this governmental strategy, in effect, reduces the role and impact of the government as a resource manager. Community-based forest management success is highly dependent on the behavior of the community members. Certain non-government and government organizations are considered "community support organizations" because of their roles in providing assistance and influencing the behavior of community groups. Five community forestry sites in the Philippines were examined in this research. The focus was on assistance the community groups received from support organizations in developing skills and abilities in forest management. The support organizations were examined in terms of their ability to provide services, use participatory methods, and build the capacity of the community group. The findings suggest that community groups were in need of much greater levels of assistance to develop collective interests in the resource and build the capacity to implement programmatic requirements in a long-term and sustainable method. Further simplifications of programmatic rules and requirements are recommended, with particular emphasis on finding ways to best meet community needs. One way for the government to influence the outcomes of this resource management strategy is to provide more incentives for field-level officials to interact and assist community groups in community-based natural resource management.

Mercer, E., A. Thompson, et al. (1999). Eco-tourism in the Blue and John Crow Mountains National Park of Jamaica, West Indies: Chapter 4. Economic demand for ecotourism development. Greensboro, NC, North Carolina A&T State University School of Agriculture. The Research Technical Bulletin Series T-141:53-69+Appendix

Moulton, R. J. (1999). Forestry in U.S. climate change action plans: from the Arch to Kyoto. Proceedings of the 1998 Southern Forest Economics Workshop, Research Triangle Park, NC, Southern Research Station.

The international community has played a major role in prompting actions to address global climate change. The 1989 Summit of the Arch in Paris resulted in President Bush's announcement in his 1990 State of the Union message of the America the Beautiful (ATB) program, which greatly expanded federal funding for urban forestry and for forest stewardship programs for NIPF ownerships; the 1992 Rio Earth Summit set the stage for President Clinton's Climate Change Action Plan (CCAP); and the recent Kyoto Climate Change Conference gave major emphasis to forestry. While never publicly announced as such, ATB was conceived and designed as the first federal effort to employ forestry activities to offset U.S. CO2 emissions. This early effort was refined at the 1993 White House Conference Climate Change Sinks Workshop, which preceded the CCAP. Forestry is in the spotlight, as the world moves toward mandatory targets and timetables following Kyoto.

Moulton, R. J. (1999). "An update: changes abound in forestry cost-share assistance programs." Tree Farmer 18(5): 10-14.

There have been some major changes in the line-up and funding for federal incentive programs that provide technical and financial assistance to non-industrial private forest (NIPF) landowners since I last reported on this subject ("Sorting Through Cost-Share Assistance Programs," Nov./Dec. 1994 Tree Farmer). The purpose of this article is to bring you up to date on some of those changes.

Panton, C. A., G. Gayle, et al. (1999). Eco-tourism in the Blue and John Crow Mountains National Park of Jamaica, West Indies: Biophysical Assessment. Greensboro, NC, North Carolina A&T State University School of Agriculture. The Research Technical Bulletin Series T-141: 8-31

Steelman, T. A. (1999). "The public comment process: what do citizens contribute to national forest management?" Journal for Forestry 97(1): 22-26.

Public comment is one of the commonly used methods for obtaining public input in national forest planning. This research explores a historically important planning exercise on the Monongahela National Forest to determine what the public actually contributed to the decisionmaking process. Although citizens generally do not offer useful technical information, the value-based information they provide helps planning staffs determine what the participating public wants. Such value-based information is more difficult to manage and respond to than technical information, however, and the Forest Service may need to adapt accordingly.

Thompson, A., E. Mercer, et al. (1999). Eco-tourism in the Blue and John Crow Mountains National Park of Jamaica, West Indies: Chapter III Planning for ecotourism in communities surrounding the BC&JCM National Park. Greensboro, NC, North Carolina  A&T State University School of Agriculture. <u>The Research Technical Bulletin Series</u> T-141: 34-52

# 2000 (7)

Boltz, F. and D. R. Carter (2000). Financial returns under stand growth and timber price uncertainties for reduced-impact and conventional logging operations in the eastern Amazon. <u>Proceedings of the 1999 Southern Forest Economics Workshop</u>, Starkville, MS, Mississippi State University, Department of Forestry.

Reduced-impact logging (RIL) systems are designed to improve the efficiency of timber harvesting, while mitigating adverse effects on residual stands and forest ecological functions. In recent years, RIL systems have been designed and implemented in experimental sites throughout the tropics, though few economic analyses of RIL have been conducted. The lack of information on the economic benefits of RIL relative to conventional logging is an important constraint to its broader adoption by the forest industry. If reduced-impact logging methods yield higher profits than current methods, it may be expected that such methods will be adopted. The objective of the present study is to compare the financial returns for the initial and second cutting cycle harvesting by RIL and conventional logging operations in the Paragominas region of the Brazilian Amazon. A diameter class model of timber growth and yield was developed with pooled data from Brazilian forests to project stand development following harvest. Results of harvest and growth simulations were utilized in the calculation of financial returns to initial and second cutting sycle harvests for each system using discounted cashflow analysis.

Butry, D. and S. Pattanayak (2000). Welfare implications of tropical forest conservation: the case of Ruteng Park. <u>Proceedings of the 1999 Southern Forest Economics Workshop</u>, Starkville, MS, Mississippi State University, Department of Forestry.

In 1993, the Indonesian government established the Ruteng Nature Recreation Park in western Flores. Subsequently, the government banned all timber extraction in and around the park's sub-tropical forest to promote biodiversity and watershed protection. This study quantitatively examines the role that tropical forest conservation has on the development of the local economy, and tests hypotheses regarding the local use of and dependence on the tropical forest. Microlevel data is taken from a rich socioeconomic survey administered to local Manggarai households residing within the park's buffer zone. This information is used to quantify the size of forest incomes, and to estimate a household profit function to characterize forest use, test for wealth differences, and identify policy levers for Ruteng Park. Given the large number of households without forest profits or an observable reservation price, a sample selection model ("Heckit analysis") is used on the forest profits censored data. Results indicate that there is a significant reliance on the forest, as forest products make up approximately 30% of total income. Furthermore, poorer households disproportional depend on forest access than do their wealthier counterparts. The policy options explored include limiting forest entry, via a tax or subsidy system.

Esseks, J. D. and R. J. Moulton (2000). Evaluating the Forest Stewardship Program Through a National Survey of Participating Forest Land Owners. De Kalb, IL, Center for Governmental Studies, Social Science Research Institute, Northern Illinois University.

From late July 1998 through May 1999, a random sample of 1,238 nonindustrial private forest land (NIPF) owners with approved multiple resource Forest Stewardship Plans were surveyed to determine if this program is meeting its Congressional mandate of promoting long-term stewardship on NIPF ownerships.  It was found that the majority of program participants had never before received professional assistance in managing their lands; 81 percent had begun to implement their plans; more than one half were undertaking practices that were new to them; and a majority of owners had adopted and were implementing multi-purpose practices.  Over 90 percent of the participants found their plans easy or very easy to understand, and two-thirds said they would "strongly recommend" FSP to other landowners.  Forest plans alone fostered improvements in stewardship behavior; but regression analysis showed that owners were significantly more likely to start to implement their plans, to manage for multiple resource outputs, and to adopt new

practices when they also received either follow up planning assistance or cost sharing for practice installation. The results were generally very consistent across four study regions: the North, South, Great Plains and Rocky Mountains, and the Pacific Coast states.

Esseks, J. D. and R. J. Moulton (2000). Evaluating the Forest Stewardship Program Through a National Survey of Participating Forest Land Owners. Proceedings of the 1999 Southern Forest Economics Workshop, Starkville, MS, Mississippi State University, Department of Forestry.

This paper reports findings from a national survey of 1,231 participants in the Forest Stewardship Program (FSP) of USDA's Forest Service. Launched in 1991, the FSP provides technical assistance through state forestry agencies to help landowners develop management plans for their non-industrial forestland. The survey allowed us to address five main evaluative questions. The answers we found were largely positive. (1) For the most part, the program was reaching the targeted clientele. Across the four regions, majorities of 57 percent to 73 percent of the surveyed participants reported that they had never before received professional advice for managing their forestland. (2) Majorities of 82 percent to 86 percent had begun to implement their plans, that is, they were carrying out management activities recommended in their plans. (3) In most cases, the practices being implemented amounted to a multiple-purpose approach to management (e.g., with the same owner pursuing both timber stand improvement and wildlife protection). (4) Majorities of 52 percent to 56 percent were applying practices that were new to them. (5) Finally, the program has stimulated its participants to spend considerable money on plan implementation beyond whatever reimbursements they received through cost sharing. Even owners who did not take part in cost share program reported significant expenditures.

Holmes, T. P., G. M. Blate, et al. (2000). Financial costs and benefits of reduced impact logging relative to conventional logging in the Eastern Amazon. Washington, D.C., Tropical Forest Foundation.

This report provides a comparison of the costs and revenues of a typical Reduced Impact Logging (RIL) system relative to a typical, large-scale Conventional Logging (CL) system in the eastern Amazon. The analysis focuses on financial, operational, and technical aspects of CL in relation to RIL techniques and procedures. Although the study does not address biological or ecological questions directly, measurements were made of two key parameters affecting future forest productivity: damage to trees in the residual stand and the proportion of ground area disturbed. An economic engineering approach was used to estimate standardized productivity and cost parameters for typical RIL and CL operations in the Paragominas, Par< timbershed. Detailed data on productivity, harvest volume, wasted wood and damage were collected from on-site harvest blocks. Productivity and cost data were also collected using surveys of forest products firms in the timbershed. The major conclusion of the study was that reduced impact logging can be financially more profitable than conventional logging. This implies that economic self interest can help mitigate the loss of ecological services in tropical forests subject to logging pressure.

Moulton, R. J. and G. Hernandez (2000). "Tree Planting in the United States--1998." Tree Planters' Notes 49(2): 23-36.

This annual report summarizes tree planting, timber stand improvement, and nursery production activities across all ownerships of forest land in the United States. It includes State-by-State and ownership breakdowns, regional totals, as well as analysis of trends in the data. It does not include tree planting in urban and community environments. As far as we know, it is the most complete compilation of such data in the country. Because some of the data are estimated, caution must be used in drawing inferences. 1998 SUMMARY: * Trees were planted on 2,624,681 acres; * Timber stand improvement was completed on 2,398,543 acres; * Nursery production totaled 1,642,089,000 trees

Prestemon, J. P. (2000). "Public open access and private timber harvests: theory and application to the effects of trade liberalization in Mexico." Environmental and Resource Economics 17: 311-334.

A common popular assertion is that trade liberalization encourages deforestation. But whether this is true depends on how trade policies affect the allocation of land among competing uses and how they influence illegal cutting of public forests. A model is presented that allows for forests to be either public or private, and public forests are divided into protected (or managed) and threatened categories. Effects of price changes are shown on each part of the forest. An empirical version of the model is applied to the case of Mexico with NAFTA. Most scenarios considered show that NAFTA

will have positive long-run effects on forest cover in Mexico but that this is net of losses on private lands.

## 2001 (9)

Boltz, F., D. R. Carter, et al. (2001). "Financial returns under uncertainty for conventional and reduced-impact logging in permanent production forests of the Brazilian Amazon." <u>Ecological Economics</u> 39: 387-398.

Reduced-impact logging (RIL) techniques are designed to improve the efficiency of timber harvesting while mitigating its adverse effects on the forest ecosystem. Research on RIL in select tropical forest regions has demonstrated clear ecological benefits relative to conventional logging (CL) practices while the financial competitiveness of RIL is less conclusive. We conduct a comparative analysis of financial returns to one and two cutting-cycle logging entries for representative RIL and CL operations of the eastern Amazon. Observed variability in harvest efficiency and uncertainties of forest productivity are introduced in a stochastic simulation of future biological and financial returns to the alternative logging systems. Despite the perceived investment risks, RIL harvesting operations generate competitive or superior returns relative to CL for a wide range of discount rates due to gains in harvest efficiency and forest conservation.

Butry, D. T., D. E. Mercer, et al. (2001). "What is the price of catastrophic wildfire?" <u>Journal of Forestry</u> 99(11): 9-17.

We modeled and analyzed the economic impacts of the six weeks of large, catastrophic wildfires in northeastern Florida in June and July 1998, among Florida's most devastating in recent history. The result of the unusually strong El Nino-Southern Oscillation (ENSO) in 1998, the Florida wildfires produced economic impacts of at least $600 million, similar in scale to recent category-2 hurricanes. Improved understanding of the interactions between management, wildfire, and its costs may yield large payoffs to society by identifying optimal intervention activities.

Ellefson, P. V., R. J. Moulton, et al. (2001). Programs and organizations affecting the use, management, and protection of forests: an assessment of agencies located across the organizational landscape of state governments. University of Minnesota.

Holmes, T. P., F. Boltz, et al. (2001). Financial indicators of reduced impact logging performance in Brazil: case study comparisons, <u>International Conference on the Application of Reduced Impact Logging to Advance Sustainable Forest Management</u>, Kuching, Sarawak, Malaysia, The Asia-Pacific Forestry Commission.

Indicators of financial performance are compared for three case studies in the Brazilian Amazon. Each case study presents parameters obtained from monitoring initial harvest entries into primary forests for reduced impact logging (RIL) and conventional logging (CL) operations. Differences in cost definitions and data collection protocols complicate the analysis, and suggest that caution is necessary in interpreting results. Given this caveat, it appears that RIL can be competitive with or superior to CL in financial returns to initial harvest entries if the financial costs of wood wasted in the harvesting operation are fully accounted for. Standardization of study methods, and replication of studies across different forest types, levels of industrial scale and markets, would allow more rigorous tests to be made of RIL relative profitability. Adoption of RIL techniques as part of a long-term forest management system faces additional challenges related to the opportunity cost of timber set aside to maintain productivity and ecosystem integrity, as well as issues regarding land tenure security.

Moulton, R. J. and J. D. Esseks (2001). Highlights of the national evaluation of the Forest Stewardship Planning Program. <u>Proceedings of the 2000 Southern Forest Economics Workshop</u>, Lexington, KY, University of Kentucky.

In 1998 and 1999, a nationwide random sample of 1238 nonindustrial private (NIPF) landowners with approved multiple resource Forest Stewardship Plans were interviewed to determine if this program is meeting its Congressional mandate of promoting sustainable management of forest resources on NIPF ownerships. It was found that two-thirds of program participants had never before received professional assistance in managing their lands; a large majority had begun to

implement their plans; over one-half were undertaking practices that were new to them; and a majority of owners had adopted and were implementing multi-purpose practices. Over 90 percent of the participants found their plans easy or very easy to understand, and 94 percent said they would recommend FSP to other landowners. Forest plans alone fostered improvements in stewardship behavior, but regression analysis showed that owners were significantly more likely to implement new stewardship practices, to increase personal non-reimbursed dollar expenditures, and to manage for multiple resource outputs when they also received follow up planning assistance and cost sharing for practice installation. Recent (post-study) reductions in federal funding for cost share assistance to implement stewardship practices may have a major adverse impact on this program.

Pattanayak, S. and E. O. Sills (2001). "Do tropical forests provide natural insurance? The microeconomics of non-timber forest product collection in the Brazilian Amazon." Land Economics 77(4): 595-612.

Tropical forests may contribute to the well-being of local people by providing a form of "natural insurance." We draw on microeconomic theory to conceptualize a model relating agricultural risks to collection of non-timber forest products. Forest collection trips are positively correlated with both agricultural shocks and expected agricultural risks in an event-count model of survey data from the Brazilian Amazon. This suggests that households rely on forests to mitigate agricultural risk. Forest product collection may be less important to households with other consumption-smoothing options, but its importance is not restricted to the poorest households.

Prestemon, J. P., D. E. Mercer, et al. (2001). Economically optimal wildfire intervention regimes, Chicago, IL, American Agricultural Economics Association. Paper presented at the American Agricultural Economics Association Annual Meeting.

Wildfires in the United States result in total damages and costs that are likely to exceed billions of dollars annually. Land managers and policy makers propose higher rates of prescribed burning and other kinds of vegetation management to reduce amounts of wildfire and the risks of catastrophic losses. A wildfire public welfare maximization function, using a wildfire production function estimated using a time series model of a panel of Florida counties, is employed to simulate the publicly optimal level of prescribed burning in an example county in Florida (Volusia). Evaluation of the production function reveals that prescribed fire is not associated with reduced catastrophic wildfire risks in Volusia County Florida, indicating a short-run elasticity of -0.16 and a long-run elasticity of wildfire with respect to prescribed fire of -0.07. Stochastic dominance is used to evaluate the optimal amount of prescribed fire most likely to maximize a measure of public welfare. Results of that analysis reveal that the optimal amount of annual prescribed fire is about 3 percent (9,000 acres/year) of the total forest area, which is very close to the actual average amount of prescribed burning (12,700 acres/year) between 1994-99.

Siry, J. P. and D. H. Newman (2001). "A stochastic production frontier analysis of Polish State Forests." Forest Science 47(4): 526-533.

This article presents a study of the efficiency of Polish state timber production and management polices following the transition to a more competitive market. The objective is to determine how well the Polish State Forests, which manage 80% of Poland's forestland and supply 85% of its timber, have adjusted, after 40 yr of central planning, to this change. The development and estimation of a stochastic frontier production function is used to analyze and evaluate the efficiency of timber production and the effectiveness of management policies. The empirical results provide evidence for the presence of substantial technical inefficiency, along with some scale economies in timber production. In addition, policies that have led to the creation of smaller forest districts, employment reductions, and logging equipment purchases are largely ineffective and perhaps even counterproductive. On the other hand, a strong support is provided for the continued privatization of forest operations.

Steelman, T. A. (2001). "Elite and participatory policymaking: finding balance in a case of national forest planning." Policy Studies Journal 29(1): 71-89.

In recent years many theorists and practitioners have called for more public involvement in policymaking and for greater citizen input in decisions. The move toward participatory and community-based approaches in policymaking can be seen as a backlash against more elitist technocratic, top-down models of decisionmaking. Using a case study of a successful National

Forest planning exercise, this research investigated whether a participatory or elite model characterized the decisionmaking process. The findings indicated that neither an elite nor participatory model of decisionmaking dominated in the planning process; rather, both forms of decisionmaking contributed to important elements in formulating this successful National Forest plan.

# 2002 (8)

Boltz, F., T. P. Holmes, et al. (2002). "Economic and environmental impacts of conventional and reduced-impact logging in Tropical South America: a comparative review." Forest Policy and Economics 5: 69-81.

Indicators of environmental impact and financial performance are compared for case studies of tropical forest logging from the Brazilian Amazon, Guyana, and Ecuador. Each case study presents parameters obtained from monitoring initial harvest entries into primary forests for planned, reduced-impact logging (RIL) and unplanned, conventional logging (CL) operations. Differences in cost definitions and data collection protocols complicate the comparative analysis, and suggest that caution is necessary in interpreting results. Given this caveat, it appears that RIL can generate competitive or superior profits relative to CL if the financial costs of wood wasted in the harvesting operation are fully accounted for. Increased operational efficiency is an important benefit of RIL, one that largely determines its cost-effectiveness relative to conventional practices. Uncertainties concerning the marginal benefits of RIL relative to familiar, profitable conventional practices pose an obstacle to broader adoption. Moreover, CL firms face few incentives to alter their operations unless they face dramatic changes in market signals. Adoption of RIL cost of silvicultural prescriptions and timber set-asides to maintain productivity and ecosystem integrity.

Butry, D. T., J. M. Pye, et al. (2002). Prescribed fire in the interface: separating the people from the trees. Proceedings of the eleventh biennial southern silvicultural research conference. K. W. Outcalt. Knoxville, TN, U.S. Department of Agriculture, Forest Service, Southern Research Station. SRS-48: 132-136.

Land managers in Florida rely on prescribed fire to prepare sites for regeneration, improve wildlife habitats, reduce vegetative competition, facilitate timber management activities, and mitigate wildfire risk. More than one million acres of land is scheduled for prescribed fire each year in Florida, nearly five times more than the area burned by wildfires. However, little has been done to understand the characteristics of communities affected by fire: who live in these communities and where are they located, where could additional prescribed burning and other wildfire risk mitigation activities be targeted, and how might continued population growth affect future tolerance for these practices? To shed light on these questions we use GIS overlay and correlation techniques to characterize and compare fire-affected zones in Florida. Characteristics studied include: population demographics, road density, neighborhood forest stand attributes, amount of forest fragmentation, and sources and frequency of wildfire ignition. We find that prescribed burning occurs in places where, on average, people are younger, earn lower incomes, have less formal education, are more frequently Caucasian, and live in more rural areas than people living in places without any prescribed fire or wildfire. High rates of prescribed burning occur in areas with less fragmented forests, more government management, and greater dominance by pine (*Pinus* spp.) forest types. Wildfires, on the other hand, occur most often in areas where forests are fragmented, ecologically more diverse, and privately owned.

Holmes, T. P., G. M. Blate, et al. (2002). "Financial and ecological indicators of reduced impact logging performance in the eastern Amazon." Forest Ecology and Management 163: 93-110.

Reduced impact logging (RIL) systems are currently being promoted in Brazil and other tropical countries in response to domestic and international concern over the ecological and economic sustainability of harvesting natural tropical forests. RIL systems are necessary, but not sufficient, for sustainable forest management because they reduce damage to the forest ecosystem during the initial forest entry. If conditions were identified where RIL costs were clearly less than conventional logging (CL) costs, then a strong incentive for RIL adoption would exist. In this paper, a comparison of costs and revenues was made for typical RIL and CL operations in the eastern Amazon. An economic engineering approach was used to estimate standardized productivity and cost parameters. Detailed data on productivity, harvest volume, wasted wood and damage to the residual stand were collected from operational scale harvest blocks. Productivity and cost data were

also collected using surveys of forest products firms. The major conclusion of the study was that RIL was less costly, and more profitable, than CL under the conditions observed at the eastern Amazon study site. Full cost accounting methods were introduced to capture the direct and indirect costs associated with wasted wood. The impact of wasted wood on effective stumpage price provided the largest gain to RIL. Large gains attributable to RIL technology were also observed in skidding and log deck productivity. In addition, investment in RIL yielded an "environmental dividend" in terms of reduced damage to trees in the residual stand and reduction of the amount of ground area disturbed by heavy machinery. Developing institutions that can monetize the value of the environmental dividend remains a major challenge in the promotion of sustainable forest management in the tropics.

Holmes, T. P., G. M. Blate, et al. (2002). Custos e beneficios financeiros da exploracao florestal de impacto reduzido em comparacao a exploracao florestal convencional na Amazonia Oriental. Belem, Brazil, Fundacao Floresta Tropical: 69.

Holmes, T. P., F. Boltz, et al. (2002). Chapter 15:  financial indicators of reduced impact logging performance in Brazil:  case study comparisons. <u>Asia-Pacific Forestry Commission International Conference Proceedings</u>, Kuching, Malaysia, Food and Agricultural Organization of the United Nations Regional Office for Asia and the Pacific.

Pattanayak, S. K., D. E. Mercer, et al. (2002). Adopting agroforestry. <u>Proceedings of the 2001 Southern Forest Economics Workshop</u>, Auburn, AL, School of Forestry and Wildlife Sciences, Auburn University.

There is growing interest in the study of agroforestry adoption because it is promoted as a technology that can generate a sustainable version of development in which economic growth occurs in tandem with 'sustenance' or protection of ecological capital. Conventional wisdom suggests that agroforestry provides substantial economic and ecological benefits to communities and households and, therefore, should be readily adopted by farmers. Yet, many attempts to promote agroforestry systems have resulted in inadequate rates of adoption. We review the literature on technological innovations in general to identify the determinants of adoption within an economic framework. We find five categories of determinants of technology adoption: *preferences, resource endowments, economic incentives, biophysical factors,* and *risk and uncertainty*. We then analyze 56 articles on adoption of agricultural and forestry technology by small holders to evaluate these factor-clusters. Ultimately, based on the criteria of (a) empirical analysis and (b) focus on agroforestry and soil-water conservation investments, we narrow our list down to 26 studies from 17 countries. We discuss in detail the direction of influence of variables in each category.

Prestemon, J. P., J. M. Pye, et al. (2002). "Understanding broadscale wildfire risks in a human-dominated landscape." <u>Forest Science</u> 48(4): 685-693.

Broadscale statistical evaluations of wildfire incidence can answer policy relevant questions about the effectiveness of microlevel vegetation management and can identify subjects needing further study. A dynamic time series cross-sectional model was used to evaluate the statistical links between forest wildfire and vegetation management, human land use, and climatic factors in Florida counties. Four forest wildfire risk functions were estimated: one for fires regardless of ignition source, and three others for fires of specific ignition sources: arson, lightning, and accident (unintentional anthropogenic). Results suggest that current wildfire risk is negatively related to several years of past wildfire and very recent site prep burning, and risk is positively related to pulpwood removals. The effect of traditional prescribed burning on wildfire risk varies by ignition source. El Ni¤o-Southern Oscillation (ENSO) sea surface temperature (SST) anomalies were also significantly linked to forest wildfire risk, but a measure of the wildland-urban interface was not significant. Although these county-level results hold promise for aggregate risk assessment, modeling at finer spatial and temporal scales might further enhance our understanding of how land managers can best reduce the longer term risk of catastrophic wildfire damages.

Wong, G. Y., J. Alavalapti, et al. (2002). "Assessing the economic approaches to climate-forest policies:  a critical survey." <u>World Resource Review</u> 14(4): 501-519.

The linkage between global climate change and forests have assumed political prominence as forest sinks are now acknowledged as a means for off-setting carbon dioxide ($CO_2$) emissions under the Kyoto Protocol targets. As such, policies to stimulate forest carbon sequestration in an open economy will require varying levels of economic information to allow for decisions that are both efficient and sustainable. This paper reviews the various economic approaches that have been recently used to examine the impacts of climate-forest policies, and discusses their usefulness for policy analysis. A suite of integrated economic-ecologic models is also reviewed to contrast with the shortcomings of static single sector studies, and a series of guidelines for future integrated research in this area are highlighted

# 2003 (7)

Huggett, R. J. (2003). An optimal subsidy program for encouraging vegetation management by private landowners to minimize costs from wildfire. <u>Proceedings of the 2002 Southern Forest Economics Workshop</u>, Virginia Beach, VA, Virginia Polytechnic Institute and State University.

Wildfire is a spatial process where fire in one spatial unit can "infect" an adjacent spatial unit. If public land abuts private land, a realization of wildfire on the private parcel can potentially burn onto the public land. The destruction of public land creates social welfare losses including the cost of suppression, loss of recreational opportunities, and loss of harvestable timber stock. Even if private wildfire does not burn over onto public land there still may be public welfare losses stemming from smoke-induced health problems and suppression costs (public fire fighting entities often suppress fires on private land) as well as timber market dislocations. Given the potential for catastrophic fire stemming from ignitions on private property, there is a compelling economic argument for a publicly subsidized program to induce private landowners to undertake vegetation management practices (prescribed burning, mechanical thinning, timber harvesting) to reduce wildfire risk on their land. The public welfare loss under a subsidized program plus the cost of the subsidy may actually be less than the expected public damages in absence of such a program. This would be the case if the sum of privately optimal actions by a group of landowners were more costly than the sum of their publicly optimal actions.

Prestemon, J. P., J. Buongiorno, et al. (2003). Chapter 11: international trade in forest products. <u>Forests in a market economy</u>. E. Sills and K. L. Abt. Dordrecht, Netherlands, Kluwer Academic Publishers: 177-199.

Pye, J. M., J. P. Prestemon, et al. (2003). Prescribed burning and wildfire risk in the 1998 fire season in Florida. <u>Fire, fuel treatments, and ecological restoration: conference proceedings</u>, Fort Collins, CO, U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station.

Measures of understory burning activity in and around FIA plots in north-eastern Florida were not significantly associated with reduced burning probability in the extreme fire season of 1998. In this unusual year, burn probability was greatest on ordinarily wetter sites, especially baldcypress stands, and positively associated with understory vegetation. Moderate amounts of lightning also were associated with greater burning probability. Factors associated with reduced burn probability included road density and nearby requests for site preparation or seed tree burns, perhaps a proxy for other intensive forest management practices. Alternative tactics may prove more effective than fuel reduction in extreme years.

Rummer, B., J. P. Prestemon, et al. (2003). A strategic assessment of forest biomass and fuel reduction treatments in western states. http://www.fs.fed.us/research/pdf/Western_final.pdf

This assessment characterizes, at a regional scale, forest biomass that can potentially be removed to implement the fuel reduction and ecosystem restoration objectives of the National Fire Plan for the western U.S. The assessment area covers forests on both public and private ownerships in the region and describes all standing tree volume including stems, limbs, and tops. Analysis of treatment areas and potential removals is included. Additionally, the operational systems necessary to effect the treatments as well as potential erosion impacts, utilization opportunities and market implications were examined.

Sills, E. and K. L. Abt (2003). Forests in a market economy. Dordrecht, Netherlands, Kluwer Academic Publishers.

Swallow, S. K., P. J. Parks, et al. (2003). Chapter 19: policy relevant nonconvexities in the production of multiple forest benefits. Economics of forestry. R. A. Sedjo. Hampshire, England, Ashgate Publishing Ltd: 303-319.

This paper challenges common assumptions about convexity in forest rotation models which optimize timber *plus* nontimber benefits. If a local optimum occurs earlier than the globally optimal age, policy based on marginal incentives may achieve suboptimal results. Policy relevant nonconvexities are more likely if (i) nontimber benefits dominate for young stands while the optimal age depends primarily on timber benefits, or (ii) nontimber benefits dominate for mature stands and also determine the optimal age. Nonconvexities may create either temporary or persistent difficulties. Policymakers may improve efficiency by exploiting the relationship between the timber- only optimum and the global optimum

Wear, D. N. (2003). Chapter 12: public timber supply under multiple-use management. Forests in a market economy. E. Sills and K. L. Abt. Dordrecht, Netherlands, Kluwer Academic Publishers: 203-220.

## in press    (2)

Prestemon, J. P. and T. P. Holmes (in press). Market dynamics and optimal timber salvage after a natural catastrophe. Forest Science .

Natural catastrophes are regular features of timber production in the United States, especially from hurricanes, fires, and insect and disease outbreaks. These catastrophes affect timber prices and result in economic transfers. We develop a model of timber market dynamics after such a catastrophe that shows how timber salvage affects the welfare of different market groups and quantifies the impacts of salvage on product markets. A theoretical framework is developed that explores how government spending to mitigate economic losses through salvage is related to the costs of intervention. Using empirical price and quantity parameters derived for Hurricane Hugo as an example, we simulate how alternative levels of salvage would have affected southern pine timber prices and economic surplus. Results show that, for this large-scale disturbance, the economic surplus generated by salvage averaged $6.25 million for each percentage change in the volume of salvaged timber up to the observed salvage rate (~16%). Consumers benefited by an average of $5.4 million for each percent of the damaged timber that was salvaged, producers of salvaged timber benefited by $6.4 million for each percent salvaged, and producers of undamaged timber lost an average of $5.6 million for each percent salvaged. Sawtimber salvage yielded welfare benefits for each cubic meter averaging more than four times those generated by pulpwood. These results therefore have implications for strategic salvage planning following catastrophic damage to forests.

Wear, D. N. and J. P. Prestemon (in press). Timber market research, private forests, and policy rhetoric. Southern Forest Science: Past, Present, Future. M. Rauscher, K. Johnsen and R. Doudrick.